INTEGRATED EDITION OF THE PETROLEUM ENGINEER

PETROLEUM Engineer for MANAGEMENT

MARCH 1961
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GREEK Operations Spread into All Branches

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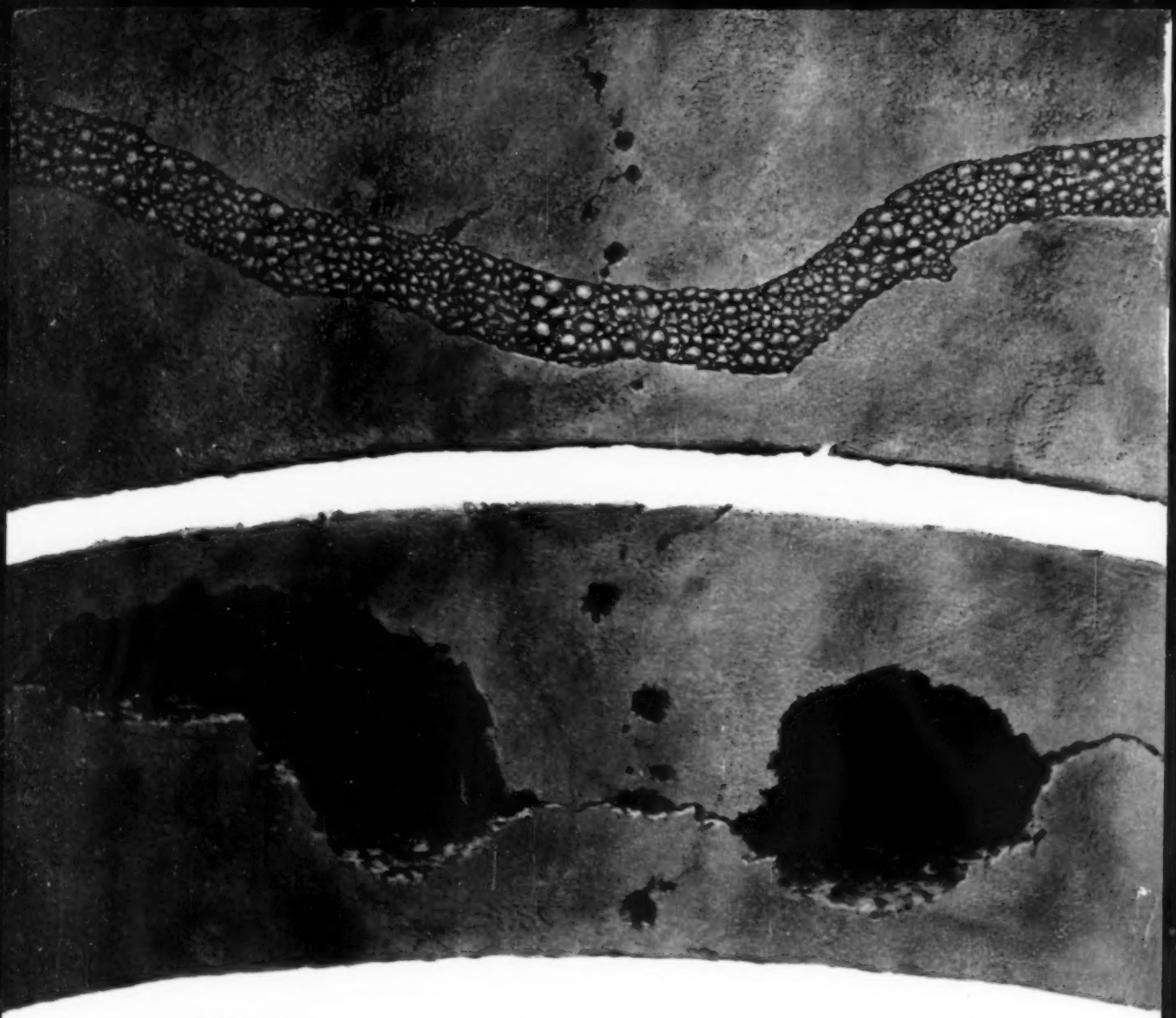

Which treatment makes the better well ?

These inside-the-well-bore views of enlarged sections of treated formation, as visualized by an engineer, compare two methods of stimulation.

The top illustration represents a sand-packed fracture after conventional fracturing. This type of treatment often gives good production increases at low cost. Many wells, however, do not respond profitably to these treatments. Small production increases, rapid production declines, or trouble with sand returns may limit profits.

The bottom illustration depicts the probable result of a new type of Dowell treatment. It uses slow-reacting Retarded Acid injected at a high rate to create open flow channels over a large drainage area. Since the etched formation supports itself, there is no need for using sand that might crush, imbed, or flow back with production. This new treatment technique is giving excellent production increases in many areas.

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highlights *and footnotes of the news*

Winter storms helped raise demand for oil products 5%, reports Chase Manhattan Bank. Heating oils ran 12% above 1960 and kerosine 30%. Gasoline gained 3%—the best January demand on record.

Texas Railroad Commission set production at 10 days for March, highest in a year. February had 8-day allowable. Humble, Mobil, Texaco and Atlantic Refining sought the higher rate.

Continental offers to buy Douglas Oil of California. Conoco President McCollum said acquisition would give his company an important foothold in fast-growing market. Douglas refines and markets on West Coast, has some production.

With startup of the initial unit at Gulf's planned petrochemical complex near Philadelphia, the company is now slightly ahead of schedule in its 10-year program of expansion into the petrochemical field that started three years ago.

Investigation of fuel oil price increase was ordered by President Kennedy. Interior and Justice Departments and FTC are working on it. Company answers: "Not out of line... recovery from sharp declines"—"industry never gets credit for price cuts"—"wage increase demands price increase."

Dean of all oil editors—Claude Barrow of The Daily Oklahoman, Oklahoma City—has retired. The industry is indebted to him for his understanding of its complexities and his ability to communicate its operations and problems.

Deciding whether water is legally a mineral, Texas Supreme Court settled a $4,000,000 suit holding that Texaco, Inc. can produce water without holding mineral rights on land in Kent and Scurry counties. High court held that a holder of surface rights was not barred from using water in area, since water was not considered in same sense that mineral rights are in making lease or sale agreements.

Pending before the Federal Power Commission at the end of 1960 were 186 applications proposing construction of 5783 miles of gas pipelines, which would cost approximately two-thirds of a billion dollars. During 1960 FPC issued 219 certificates authorizing the building of 5784 miles of gas lines at an estimated cost of $787,000,000.

Mountain Fuel Supply contracted to buy De Kalb Agricultural Association (Utah) natural gas output at 16½¢/mcf. Some 500,000 mmcf are involved. A $10 million pipeline will be built (with Utah Natural Gas Company) to market it.

The expanding petrochemical industry is already producing more than 30% of the total chemical production in the U.S.—56.1 billion lb. More than 100 petrochemical plants now operate in the Gulf Coast area alone.

An automatic welding technique and equipment that does not require rotation of the pipe has been developed by Esso Research and Engineering Company. The process makes automatic welding in the field a reality for the first time.

Things to watch: Oil import hearings before Interior Secretary Udall...national fuel policy study, which is already out of House Committee on Rules...Organization for Economic Cooperation and Development proposal on natural resource department.

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How Much Is A Supply Store Worth To You?

Recently a leading manufacturer said to me, "The supply stores are just a necessary evil...for the most part just order takers. We still have to go out and sell the customers."

Some two days later, a top supply man said to me, "Too many manufacturers expect too much from the supply company. They want us to apply the hard sell, assume the credit risk, and yet they fail to adequately advertise or merchandise their equipment to the industry."

Today's cloudy economic atmosphere creates this kind of controversial situation, and because of the atmosphere there is merit in the viewpoints of both of my friends, diametrically opposed though they may be.

Despite some "For Rent" signs on buildings in the oil patch that once housed supply stores, there's no need to push the panic button. The dependence placed on the supply stores by those in the field remains well-founded, and thanks to the business effort and faith of the suppliers, it is doubtful that there will be cause to question this dependence. But there are definite trends and factors at work today that put the supply company in a tough spot.

Here are just a few:

1) Large, unwieldy accounts receivable.

2) Profits actually less than the interest on U. S. Government Series E savings bonds.

3) Many sizable customers selling out or merging with larger firms.

4) Drastic reductions in customer budgets.

5) Pressure to cut list prices under stiff bidding practices.

6) Customer demands for high trade-in value on worn out equipment.

7) Trend of customers demanding manufacturers by-pass supplier and sell direct.

8) Customer demands for expensive fringe services.

All are symptoms of a drastic economic change that has hit the supplier with a stinging impact.

How can he cope with these measures instigated by old customers? Should there be only one big supermarket supplier in a given area? Should each of the present suppliers reduce to a minimum the scope of their operations? Should they sell only on a cash basis? These are some of the stark possibilities facing the suppliers today. Would any of these appeal to you? How much would it cost your company in manpower, time, and effort, as well as dollars, to maintain your own equipment and material normally purchased through local supply houses? Have you thought of the hundreds of different manufacturers you would have to deal with, from nuts and bolts all the way to engines and pumps? Who would be responsible for the inventory, for warehousing, for distribution? Think of the money that would be tied up in such an inventory. Does this shake you up?

What the petroleum supplier of the future will look like, and what services and facilities he offers will in a large part depend on what he can do and still make a reasonable profit. Can you afford to operate without your supplier? We believe the oil companies, the manufacturers, and the suppliers themselves should earnestly seek the true answer. The right answer is of vital economic importance to the industry.

Joe B. Hoode

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Memo to Management:

ONE BILL... ONE RESPONSIBILITY MEANS A BIG SAVINGS TO US...

Whether it's power for a pipeline, refinery or pumping, many oil companies prefer to purchase dependable utility electric power and get all power bills on one convenient monthly invoice. Utility electric power works 24 hours a day or operates on any fractional time schedule . . . in any case you pay only for the power used and eliminate many worries. For details contact your nearest Utility Electric Power Company.

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A list of P.E.P.A. members will be furnished on request.

Course of Oil

less expansion but more progress

IF SOMEONE SAID, "We've made more progress in the petroleum industry in the last two years than in any two since the war" would you agree?

It depends on what progress means to you. Webster gives as the first literal meaning "to go ahead" and more specifically "advance to an objective." So progress must be related to our objective.

The first objective of our industry is to make petroleum products easily usable and available to consumers at the lowest possible cost. To do that we must have forceful companies, whose managements efficiently apply capital to collect competent staffs, to plan development of resources, and to select the operations that will attain their objective.

After the war we were so busy expanding to meet immediate needs that progress took second place. Companies added employees because manpower was limited and they would need them later. They enlarged old refinery units because it was quicker and demand was on their heels. They drilled development wells close together to get faster production. Make-shift service stations mushroomed at every country store. Great pipe cylinders were thrown across the nation and producers contracted to sell that by-product, natural gas, for little more than a song.

There wasn't really time to think in this hectic period of expansion. Progress entered more often by accident than design.

There were worried glances at Washington where the sword of taxation and controls hung over their heads by a thin thread. When the Korean incident came, if you spent three months in Washington you might find someone who could let you have a little white market pipe. Then Suez put you on your mettle again. Got to supply Europe, you said, and expansion forgot progress entirely.

Prices went up and the thin thread holding the Washington sword became elastic. It swayed and dipped and cut. But oil went where it was needed and no nation suffered.

When that crisis passed, there was time and necessity to think of progress. Companies had to focus on objectives with more thought and effort than they had been forced to use in two decades. Expansion, they found, is not always progress. "More efficient operations" is not just a phrase for a conference or the annual report. It means intelligent, devoted management. It means a streamlined staff with ideas and room to develop them. It means research for improved technology to cut waste and for new products to fill neglected needs. It means a profit margin that will bring capital to provide the tools of progress.

Because the economy took a breather our industry is leaner, quicker, more alert — ready "to go ahead." It probably has gained more in competence and efficiency in the last two years than in any other like period since the war. It has learned that "growthmanship" can be mere inflation of capacity without real gains.

Progress is dynamic, creative, efficient, daring. Progress implies quality of operations and products and service.

Be concerned then with progress — and growth will follow as surely as heat expands air.

— Ernestine Adams

Congrats and $25 for this quip to DEAN H. CROWELL, 5919 Vickery Boulevard, Dallas, Texas

Joe Roughneck's seen dusters in his day, but he's brought in many a producing well, too. And throughout the years, Joe's been the one to specify Lone Star API pipe. He knows it's tough, dependable and available conveniently in the heart of the oil country.

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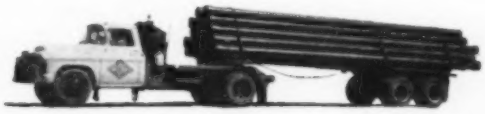

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petroleum profile

TOWERING JOHN WHITFIELD MECOM is the modern edition of a great wildcatter. He's a man who backs his faith that he knows where oil lies beneath the poker surface of the earth and events have proved he's tuned in.

John grew up in the oil business. Anyone who can remember the Gulf Coast area in the early 20th century would recognize his father's role. Harvey Mecom was a contractor, a ranchman, and an oilman. There was so much to be done in the young country and so few managers. John absorbed this atmosphere where a multitude of things had to be done, and, yet there wasn't great pressure to mesh all the time gears. This is the heritage that John Mecom has made his own—a calm deliberation that disguises his dynamic course.

He's a man with a well-scrolled purpose—he wants to find oil and gas. Fortunately he has a wife who rates an associate-wildcatter certificate and his business associates and employees are all on the line, too. He's either the champion employee-relations manager or he's too lucky for this world.

First record of John Whitfield Mecom is in El Paso on

JOHN W. MECOM
Independent
Houston, Texas

January 13, 1911, when Harvey and Louise Mecom registered their new son. He grew up in Liberty, Texas, between Beaumont and Houston. After a year at Rice Institute he went to Oklahoma University for petroleum engineering. He quit before he got his degree and worked four years in the oilfields, at a time when oil dipped to 10 cents a barrel. He was roughneck, foreman, and engineer.

At the ripe age of 25 he set up in business for himself as an independent oil operator. This took a little capital and know-how. He supplied the know-how, and the capital came from Mother, $700 in cash; from two partners, $700 each, and from his father, an old wooden derrick. The partners bought a depleted lease, drilled and found a new pay sand. After two years John got $100,000 for this venture. You could retire on that in 1938. Instead, he bought a new rig. In a couple of decades he would increase that first enterprise a thousand-fold.

With his inquiring mind, he had to probe the earth. "What makes a good oil man?" he was asked. "Curiosity," he said and certainly this is the trait that pushed him on. In these early days he was a wildcatter of ideas more than of areas. To him depletion was lack of good technique. He was fascinated by the possibilities passed over by those in a hurry.

In 1945 John Mecom was a well-to-do independent oil operator. He had married lovely Mary Elizabeth Withers in 1938 and they had three children, John W. Jr., Betsy, and Lannie Lou. Devoted to his family he might have settled down to administration of his holdings. But a born wildcatter never minds rocking the boat. He acquired a lease at High Island, a salt dome, and drilled far on the north flank. Salt dome structures are a trier of souls and John took a long chance on a far-away site. He hit.

Later he made a fateful contract with Ernie Cockrell—who owned land on the Mississippi Delta. Cockrell felt he should have some oil under it some place and he wanted Mecom to find out. John had quite a name by now and finally the two came to terms. Deep on a salt dome flank there in 1951, he brought in Lake Washington field—now the second largest inshore field in Louisiana. It was here that Richardson & Bass and Freeport Sulphur, then in partnership in the field with John Mecom, discovered in 1958 what is still the deepest production in the world, at 19,788 ft. As Mecom says, "We've found it's down there. All we need is a price to bring it up." He has drilled 39 wells below 15,000 ft; has recently spudded in a 26,000-ft project.

Mecom, like all independent oil men, relies on his bankers. In fact, in the early days he relates that he would complete a well at High Island and then rush to borrow $85,000 to meet bills. When Mecom was asked, "What was the most exciting event in your career?" He replied, "It must have been the time when I was out of debt for thirty minutes." It took him 30 minutes to take a check for $6,000,000 to the bank. Within two years thereafter he had borrowed from banks over $19,000,000 just on his signature and without mortgages, which figures to be some sort of a record for an individual wildcatter.

John Mecom has not been satisfied with searching in his back yard. He has drilled in Haiti and Honduras (unsuccessfully), but in Colombia he has nine producing gas wells on concessions totalling approximately 2½ million acres; at present, he is negotiating on Middle East areas.

Managers of John Mecom's caliber are always scarce so he's got himself into other lines. He's a commercial rancher; he owns Cardwell Manufacturing Company (drilling rigs); and manufactures fiberglass boats. In addition, he is the principal owner of Boonton Molding Company, of Boonton, New Jersey, dinnerware and custom plastic molding; and is substantial owner of Houston Chemical Corporation, which is constructing a $27 million glycol and TEL plant in Beaumont.

There are few men who can build and hold such an industry complex, larger than many substantial corporations. This modern wildcatter has a thousand decisions to make besides the one of where to drill. If you ask how he can do it — here are some off-the-cuff answers. First, he has the detachment of a philosopher, which is rare in such enterprisers as John Mecom. He creates extraordinary bonds of loyalty because of his attitude of interest in and respect for people. His family ties have evidently deepened his sense of security. If any one is in a precarious position in this world — it's a wildcatter. Although John Mecom lives a life packed with action, he gives you the impression he's just calmly clipping coupons from triple A bonds.

RUST-OLEUM®

STOPS RUST!®

and matches ORIGINAL EQUIPMENT

COLORS

Distinctive as your own fingerprint. Accept no substitute.

How much does rusty equipment cost *you*? With Rust-Oleum, you STOP RUST—and you match original equipment colors, too, for long-lasting protection!

We want you to see for yourself how *easy* it is to use Rust-Oleum . . . actually take the brush and see how smoothly it works, how it dries to an *attractive, high-gloss finish* that resists sun, fumes, rain, heat, snow, salt air and salt spray, and blowing dust and sand. And the same formula can be applied by brush or spray. Just check the coupon for the color you want . . . and attach it to your business letterhead for a FREE TEST SAMPLE. No cost or obligation.

Your Rust-Oleum Distributor maintains complete stocks for immediate delivery.

ATTACH COUPON TO YOUR BUSINESS LETTERHEAD FOR FREE TEST SAMPLE

CHECK COLOR TO MATCH YOUR EQUIPMENT

RUST-OLEUM CORPORATION, 2583 Oakton St., Evanston, Ill.
Please send me a FREE TEST SAMPLE in the color checked:

- ☐ 769 Damp-Proof Red Primer
- ☐ 634 Quick Drying Black
- ☐ 2766 High Gloss White
- ☐ 470 Ready Mixed Aluminum
- ☐ H-4 Caterpillar Yellow
- ☐ 722 Bethlehem Yellow
- ☐ 726 New Emsco Green
- ☐ 727 New Unit Rig Gray
- ☐ 724 Waukesha Gray
- ☐ 721 National Blue
- ☐ 723 Oil Well Orange

the conference table

Big Volume, No Profit

"Make the quota profitably, or else it won't matter that you made the quota at all," advised W. H. Miller, vice president, American Oil Company. Speaking to a sales conference of The Wayne Pump Company in Salisbury, Maryland, Miller cited the story of "the man who took a five-cent loss on every item he sold, but counted on large turnover to keep him in business.

"There are too many people," said he, "who are actually following that practice without ever realizing they're doing it."

That's part of what we meant when we said on page A-6 that "expansion is not always progress."

"Motorists Pay More

. . . Than Their Share of Highway Costs" — reads the lead editorial in *The Saturday Evening Post* for February. We are glad to see a consumer magazine explain so clearly how taxes mount on motor vehicle transportation yet $1.7 billion go into the general fund.

Ahead of the Liberal Economists

For the last year we've had pounded into us by such economists as Galbraith, Kennedy's economic adviser, and others of like hue, that we selfish consumers were spending all our money on automobiles with long tail fins and not enough on the public needs.

Figures indicate that the economists are following a road already taken by the self-centered consumer. These data from the U. S. Department of Commerce for 1955 and U. S. News and World Report show that in 1960:

— 25.8% less of the consumer dollar was spent for autos.
— 30.0% more of the consumer dollar was spent for education in colleges and private schools.
— 8.9% less was spent for clothing.
— 22.2% more was spent for medical care.
— 5.7% less was spent for food.
— 16.7% more was spent for church and other donations.

These interesting trends seem to have confounded both the economists and the economy.

Aluminum Industry Began 75 Years Ago

The photo on this page is the statue of Charles Martin Hall, discoverer of the electrolytic reduction process for aluminum. It appears in Severance Chemical Laboratory at Oberlin College from which he graduated on July 1, 1885. His discovery was made in the woodshed of his family home in Oberlin eight months later. Aluminum statue was presented to Oberlin in 1928 by Richard B. Mellon.

This year the aluminum industry celebrates its 75th year.

Dictators always look good until the last minutes. — Thomas G. Masaryk.

Such Startling Candor!

Interior Secretary Stewart Udall said he will not shrink from using public works proposals as a political tool to pressure Congressmen into supporting the Kennedy Administration's legislative program. At a press conference Secretary Udall denied there was anything improper in the role he played in urging various Western representatives to vote for an expansion of the House Rules Committee so Administration bills could come quickly to a vote.

Asked whether those he talked to voted the "right way," Mr. Udall, a former Arizona Congressman, said: "I got a result or two." He termed Executive Department pressure on Congress part of the traditional "rules of the game."

The public seldom forgives twice. — Johann Kaspar Lavater.

Texaco Installs New, Fast Computer

Texaco has installed and placed in productive operation the International Business Machines' IBM 7090, valued at about $4,000,000. In the company's Houston, Texas, office, it is the first placed in industrial service in the Southwest. Another one of the machines is in use on a government project at White Sands, New Mexico.

Significant Gas Industry Statistics

Records for the natural gas industry are impressive. Here are actual figures for 1960 and estimates by Dean Hale, editor of *American Gas Journal*, of what is coming in 1961:

	1960	1961
Customers on December 31	33,458,300	34,400,000
Miles of new mains installed	12,100	12,600
Miles of new services installed	7,200	7,600
New customers added	901,000	950,000
Total revenues for year	$ 5.675 billion	$ 6.0 billion
Unit sales of appliances	8.02 million	8.5 million
Gross Plant 12/31/60	$ 21.9 billion	$23.6 billion
Cu ft proved reserves	262.6 trillion	
Construction expenditures	$ 2.375 billion	$ 2.375 billion

Foreign Orders Help Lone Star

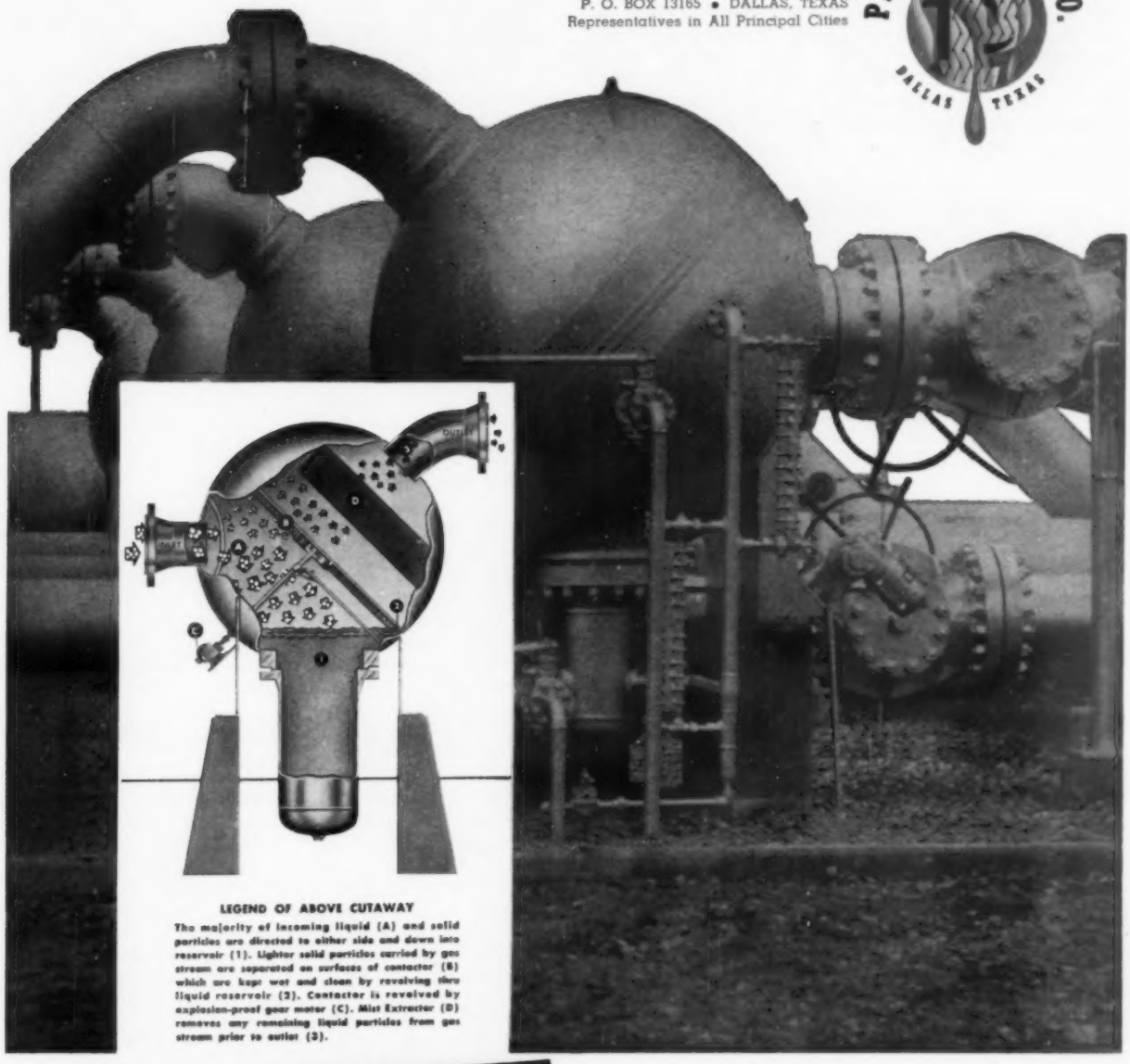
Lone Star Steel Company has resumed operations in three major departments to manufacture goods for export. E. B. Germany, president, announced the new production schedule and said half the personnel in layoff status would be called back.

Increased production, officials said, is the result of orders received from Western Europe for steel skelp (coiled plate used in the manufacture of pipe) and from domestic users of tubing, casing, and line pipe in the oil and gas industry.

Commenting on the upturn of domestic business, Mr. Germany said "This upswing, while relatively light at the moment, was expected, and we anticipate that it will continue on a gradual basis for the next several months."

PEERLESS MANUFACTURING COMPANY

Walnut Hill Lane at Old Denton Road
P. O. BOX 13165 • DALLAS, TEXAS
Representatives in All Principal Cities



LEGEND OF ABOVE CUTAWAY

The majority of incoming liquid (A) and solid particles are directed to either side and down into reservoir (1). Lighter solid particles carried by gas stream are separated on surfaces of contactor (B) which are kept wet and clean by revolving thru liquid reservoir (2). Contactor is revolved by explosion-proof gear motor (C). Mist Extractor (D) removes any remaining liquid particles from gas stream prior to outlet (3).

OPERATION PROVES
It's Cleaner Gas with
PEERLESS
SCRUBOSPHERES

Operation of these four 66" I.D. Scrubospheres has demonstrated their superiority over conventional oil bath dust scrubbers. The dust removal ability of the SCRUBOSHERE is outstanding because it utilizes wetted surfaces for dust collection which are more closely spaced than in conventional equipment.

Operation of these Peerless units has also proven their superiority with respect to minimum oil loss, because oil is periodically removed from the Scrubospheres whereas **it must be periodically added to other scrubbers** in the same plant operating under comparable conditions. Patent applied for.

Let your Peerless Representative give you full details.

"OVER 20,000 SEPARATORS and SCRUBBERS IN SERVICE"

Parkinson's Laws Basic

The British humorist, C. Northcote Parkinson, may not be as widely publicized as Albert Einstein, but his laws are just as basic in another field. His first book presented the law that "Work expands so as to fill the time available for its completion."

More recently Parkinson came up with another fundamental law: "Expenditure rises to meet income."

No one can challenge that, but you could add "Expenditure seldom follows a falling income."

"Economists have long emphasized that the true meaning of economic advance is not material but human; increasing freedom to choose and to act."—Peter F. Drucker

Index Labor Union Periodicals

The University of Michigan, Bureau of Industrial Relations, is issuing a new index of trade union periodicals which should be of value to teachers, research workers and students in the field of industrial relations as well as management. Sample copies and a list of the periodicals indexed can be obtained by writing Mrs. Gretchen Foster, circulation manager, Bureau of Industrial Relations, University of Michigan, Ann Arbor, Michigan.

"The world is divided into three groups: the small group who make things happen; the larger group who watch things happen; and the multitude who never know what happens."

It's the Slow Down

Choc Hutcheson, a Lubbock independent, is quoted by UPI as saying the oil business is so slow these days, he has quit looking for gushers. He'll be content with oozers.

The hardest thing to stop is a temporary chairman. — Kin Hubbard.

Companies Face Fundamental Changes

Substantial changes in the structure and character of business organizations in the future are foreseen by H. G. Vesper, president of Standard Oil Company of California, Western Operations, Inc.

Vesper noted in a recent speech that tomorrow's managements would direct organizations manned by a higher proportion of professional workers and made more efficient and effective by widespread application of electronic data processing equipment.

The trend toward professionalism, he predicted, will probably necessitate some fundamental changes in the pattern and lines of organization as they exist in today's business concern.

"The primary reason for this appears to be psychological rather than economic," Vesper pointed out. "Professional people generally attach particular importance to job satisfaction and status. Participation in decision-making affecting their projects or programs is especially important to them. This means that the organizational structure will probably in time require modification to meet these needs," he observed.

One partial solution to this problem has already been put into effect at Standard, Vesper said. This is a separate promotion ladder for professionals, parallel to that which exists for management people.

Vesper also predicted the business organizations of the future would make increasing use of so-called "task groups," mixed groups of specialists who get together to consider problems or programs cutting across departmental lines.

"I would imagine that in the future we will see increased use of this approach to problem-solving. It is effective in getting the job done, and it also meets the psychological needs of professional employees," he declared.

Vesper cautioned, however, that industry's progress is threatened by influences tending to make it less flexible. He cited among these—

Increasing physical size of companies — "As they gather momentum in a particular direction, it becomes increasingly difficult to change their ways," and labor legislation and social considerations — (which) "make it more and more difficult to adapt employment to changing workloads."

"Tomorrow's management," the Standard executive summarized, "will have as one of its foremost responsibilities the continuing task of finding new and better ways to preserve and improve flexibility in corporate structures and procedures."

Education doesn't tell you what to do, but it gives you some hints on how to undo what you shouldn't have done.

When Small Men Cast Long Shadows

Every segment of American business should speak out on anything that would tend to destroy our economic system. Do you remember this sentence taken from a Warner & Swasey advertisement, "When small men begin to cast long shadows it is a sure sign that the sun is setting"?

And too many very small men are casting deeply black shadows across America today.

Small-minded business men, more interested in making an easy dollar by manipulation than a harder dollar by producing values.

Petty politicians who act as though they **rule** the people rather than serve them.

Selfish labor leaders more interested in power than in America, even though their greed brings high costs, destructive inflation, deadly depression.

Greedy people in many walks of life, who want their areas, their special interests supported by all taxpayers, when they ought to be paying their own bills.

Long shadows like these will continue to grow until the entire country is in eclipse, unless the **real** people, who do the work and pay the taxes, wake up to their responsibility and opportunity. By voice and vote, they can take their country back again, and insist on honest values once more, greater public integrity, and hard work so that everyone will earn what he gets. And we had better **do** it, before the sun sets.

The recognition of honest values — integrity — hard work — earning what we get — these are the ingredients which gave this country its stature, its heart, its power. And on these foundations America was built.

But that was yesterday.

How about today?

What about tomorrow?

Unless we re-examine ourselves, unless we cast down the false gods and rid ourselves of personal greed and irresponsible attitudes, the sun will not shine on our tomorrow. And if we, the people of the greatest country the world has ever known, stumble and fall in the darkness, mankind will have enjoyed but a brief moment of freedom's shining light.

Paisley Boney, President
National Association of Purchasing Agents

Key to Automation

Labor is more expensive than capital so capital is substituted for labor. That weighs the balance for automation.

Good Wells Make Good News

Reports Showing How Dowell Helped Operators Improve Wells

March, 1961

Here are four recent cases showing how Dowell products and services have helped operators increase net profits from wells.

- **Calcasieu Parish, South Louisiana** (Old Oil Well) Production from this well had remained 40 bopd with 400 psi flowing pressure during 10 months following completion. Pay was the Miocene from 10,528 to 10,542 feet. The operator suspected mud damage to the formation. Dowell injected 40 gallons of Mudban* in 2000 gallons crude followed by a flush containing a Dowell foaming agent for oil. Treatment was performed with Christmas tree in place. After treatment, well flowed 8 to 10 barrels mud, then cleaned up. Production rose to 120 bopd with 1200 psi flowing pressure.

- **Barber County, Kansas** (Abandoned Oil Well) This well in the Rhodes pool had been down for eight months. Pumping unit, rods and tubing had been removed and the well had been sold to the present owner for salvage. Dowell treated well with Blue Paraffin Solvent; a Dowell solvent designed for paraffins containing asphaltic material. Before treatment, a swab test showed no fluid. 50 gallons of Paraffin Solvent and 1000 gallons kerosene were circulated and then displaced into the formation. After treatment, well swabbed 13 bopd and was put on pump.

- **Upton County, West Texas** (New Oil Well) This well was completed open hole into the Ellenburger between 12,311 and 12,327 feet. The formation would not break down at 5000 psi -- the permissible surface working pressure. The operator decided to use Rockshock* implosion service to reduce breakdown pressure. Lowell ran four 10-inch glass capsules and imploded them opposite the pay. Formation then accepted 7500 gallons acid down two-inch tubing at 4100 psi and 3 bpm. Before treatment, the well swabbed dry. After treatment, it flowed 354 bopd through a 20/64-inch choke.

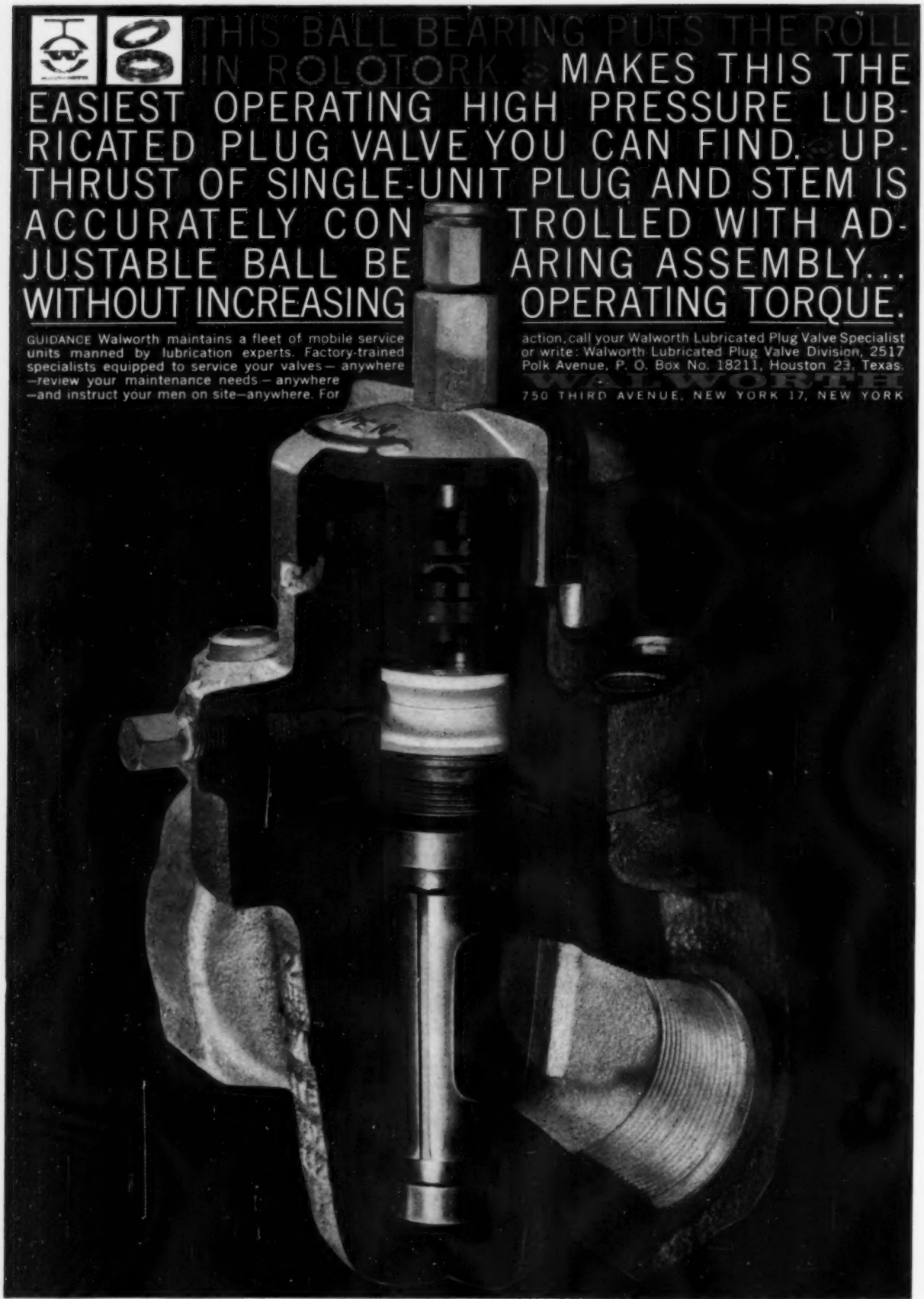
- **Wayne County, Illinois** (Old Oil Well) The operator of this pumping well had been plagued with rod breaks. Production of 5 bopd and 50 bwpd was from the Aux Vases sand. Thirty-five ¾-inch rods had to be replaced during the twelve-month period before Dowell was asked to start a corrosion inhibitor treating program. One pint of Corban* 207 was dumped down casing every other day. There was not a single rod break during the first year after treating was begun. Down-hole equipment and tubing also remained in good condition. Treatment cost was only $60.00 per year.

Talk your production problems over with your Dowell representative. The chances are good he can help you improve production or decrease costs with Dowell products or services. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma.

*DOWELL TRADEMARK

Services for the oil industry DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY


THIS BALL BEARING PUTS THE ROLL
IN ROLOTORK
MAKES THIS THE EASIEST OPERATING HIGH PRESSURE LUBRICATED PLUG VALVE YOU CAN FIND. UP-THRUST OF SINGLE-UNIT PLUG AND STEM IS ACCURATELY CONTROLLED WITH ADJUSTABLE BALL BEARING ASSEMBLY... WITHOUT INCREASING OPERATING TORQUE.
GUIDANCE Walworth maintains a fleet of mobile service units manned by lubrication experts. Factory-trained specialists equipped to service your valves – anywhere –review your maintenance needs – anywhere –and instruct your men on site–anywhere. For action, call your Walworth Lubricated Plug Valve Specialist or write: Walworth Lubricated Plug Valve Division, 2517 Polk Avenue, P. O. Box No. 18211, Houston 23, Texas.
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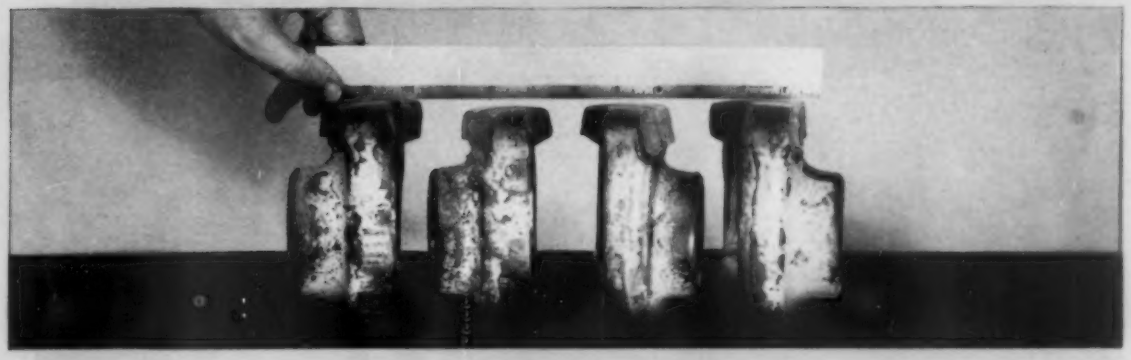
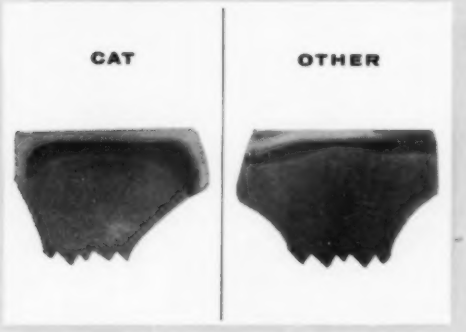
Special Report to Users of Caterpillar Equipment:

WHAT YOU DON'T SEE CAN HURT YOU

You can buy a lot of parts that *look* like genuine Caterpillar parts. Some may be cheaper initially. But they are as different as night and day when you get them in service.



Take these links, for example. They all *looked* identical when new. But see what has happened after 2000 hours on the same D8 Tractor! The two links in the center, a popular brand with induction-hardened rails, cost about 9% less than Caterpillar links originally, but showed about *50%* more wear.



The extra service you can expect from the Cat links can be seen and compared with other brands. Here are actual photos of etched cross sections of *production* links made by Caterpillar and the other manufacturer. The light areas at top show case depth and pattern of wear-resistant rail material resulting from heat treatment. See the deep, uniform wear case on top *and sides* of the Cat part? It's as hard as a good ball-peen hammer head. But in the other brand, the wear case varies both in depth and hardness . . . that's the reason why after 2000 hours on a D8 the Cat-made links had worn 50% less.

Investigate and you will find superiorities for every undercarriage component built by Caterpillar. This extra quality—though it sometimes costs a little more initially—pays off by delivering *extra* trouble-free working hours. That's why genuine Caterpillar parts cost you less per hour than other brands.

And when it's time to replace or rebuild your tractor undercarriage, see your Caterpillar Dealer. He is an undercarriage specialist with modern facilities to back him up. Get the full story on his many money-saving options and recommendations *tailored to your job conditions.* Truly CUSTOM TRACK SERVICE, designed to save you money . . . and offered only by your Caterpillar Dealer.

Caterpillar Tractor Co., General Offices, Peoria, Illinois, U. S. A.

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FIRST NATIONAL BANK IN DALLAS

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TERRIFIC!

—and how long will the flexing member last?

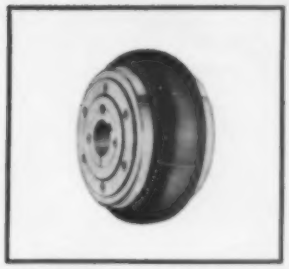
Good question. The heart of Para-flex is a tire with synthetic tension members bonded together in rubber—which provides a flexing body that automatically compensates for *all combinations* of misalignment and end float, and absorbs vibration as well!

This amazing coupling has now been used in American industry 4 years. Thousands are in operation—in steel mills, paper mills, oil fields, mines, quarries, chemical plants, everywhere—and in these 4 years, replacements of elements have been negligible.

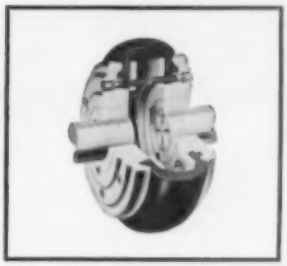
Dodge Standard Para-flex takes angular misalignment up to 4°, parallel misalignment up to 1/8" and end float up to 5/16" depending upon the size of the coupling and the duration of shaft displacement.

Dodge Para-flex is available in 3 types—Standard, Flywheel and High Speed (shown at right). The Standard type is stocked in capacities up to 3640 hp at 910 rpm. Ask your Dodge Distributor, or write us for complete technical bulletin.

Dodge Manufacturing Corporation, 7900 Union Street, Mishawaka, Indiana



The new idea in flexible cushion couplings, with a flexing member that "swallows up" misalignment.



No lubrication, no maintenance. Replace flexing element without moving driver or driven machine.

Flywheel and High Speed Types. For use with motors and internal combustion engines turning up to 5230 rpm.

The Products with the Pluses...

DODGE

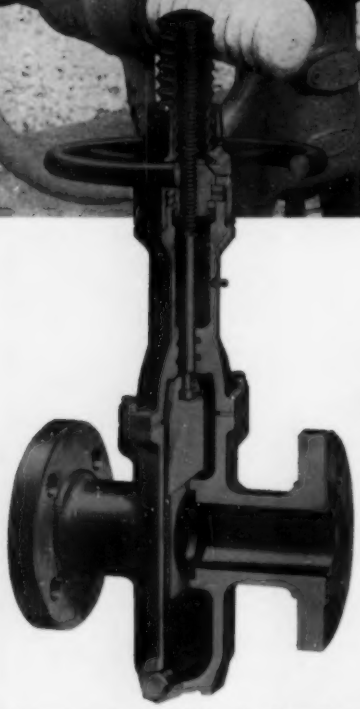
of Mishawaka, Ind.

DODGE

Para-flex

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge he can give you valuable assistance on new cost-saving methods.

4" W-K-M Pressure Sealing Gate Valves serve as emergency shut-off for regulator handling hot P.B.C. at 440 psi, in natural gasoline plant.



Floating Seats Make Sealing Easy

Seats are specially formulated elastomer molded to a hardened steel insert. When the gate closes, line pressure forces the gate against the downstream seat making a tight seal. The upstream seat floats against the gate to maintain an upstream seal.

Emergency shut-off is a cinch with W-K-M's Pressure Sealing Gate Valve

A unique W-K-M seat design makes line pressure do most of the work — sealing the seats to positive shut-off, upstream and down. But easy operation is only part of the story.

W-K-M's new Pressure Sealing Gate Valve is ruggedly dependable. It automatically compensates for seat wear, automatically relieves excessive body pressure. And on-the-line overhaul is a simple matter.

Wherever you need a smooth-operating valve for pressures to 720 psi and temperatures to 250° F., specify W-K-M's new Pressure Sealing Gate Valve. Sizes 2" through 30" — at leading distributors.

WRITE FOR CATALOG 1200

W-K-M

DIVISION OF ACF INDUSTRIES
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6009

CLIMATE... IS NO OBJECT!

With the UGC Instruments Gravitometer!

CORRECTS AND COMPENSATES FOR VARIATIONS IN temperature — humidity — barometric pressures — dust.

Under any climatic extreme the all mechanical GRAVITOMETER measures specific gravity for use in orifice meter measurement. No *controlled* or *conditioned* atmosphere is required, and there are no complicated or critical adjustments to make for atmospheric variations.

The GRAVITOMETER was designed to eliminate errors in the float-type gravitometer when variations occur in the temperature and density of the atmosphere surrounding the sample float.

The GRAVITOMETER can be installed without the use of highly trained technicians, and is easily operated and maintained. Completely automatic, it produces positive, accurate and correct specific gravity measurements.

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For Further Information Phone or Write:
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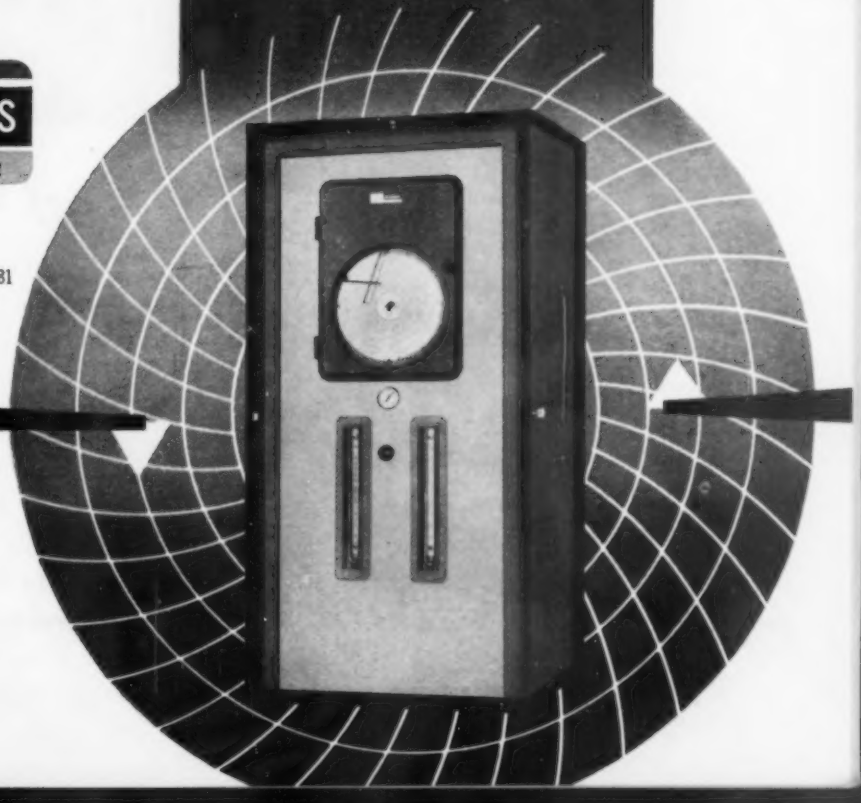
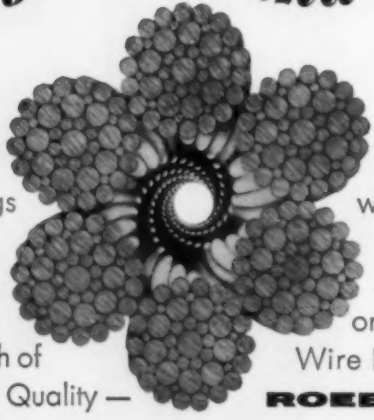


We put a lot of work into it
You get a lot of work out of it

quality inside and outside



Take a good look at the pictures. They show you where your savings really start — with the inner and outer uniformity of wires and strands. Unseen, but of utmost importance is the *extra* high strength of Roebling Royal Blue Wire Rope. Quality — inside and outside — is the extra working factor that pays off on the job for *you*. Find out more from your wire rope distributor, or write for free booklet to Roebling's Wire Rope Division, Trenton 2, N. J.

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John A. Roebling's Sons Division
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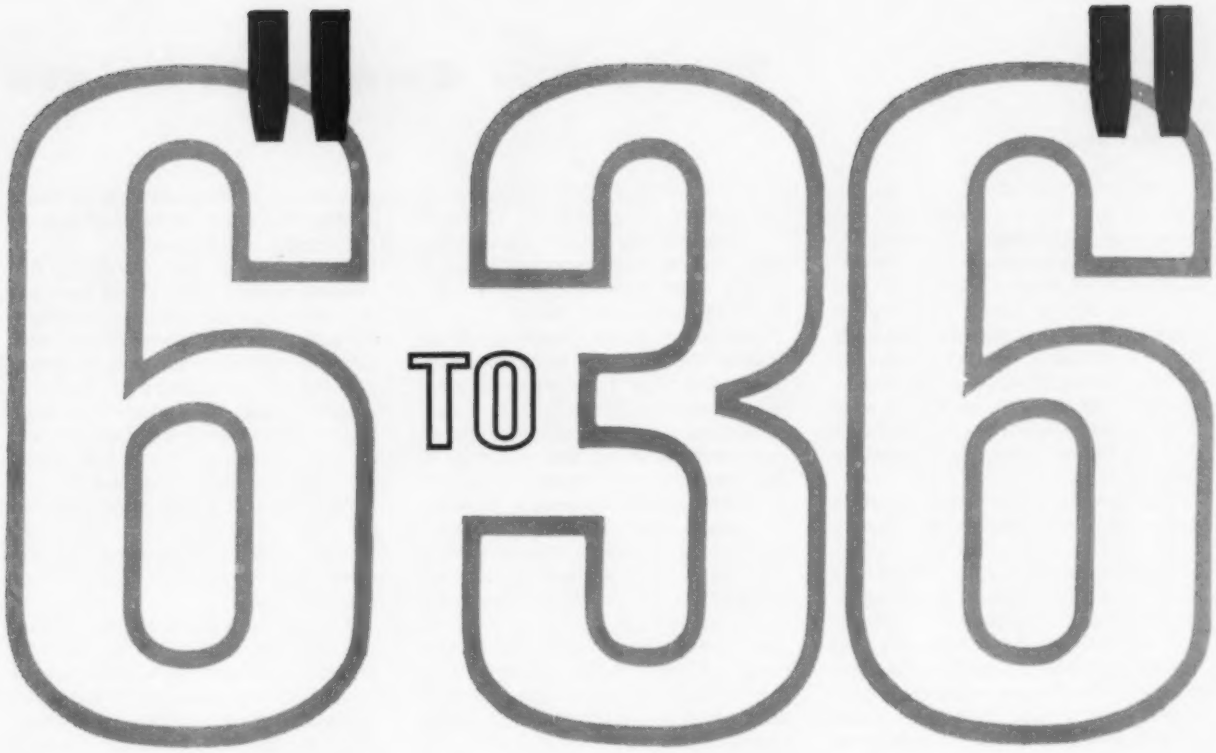
FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD



What Size Line Pipe Do YOU Need?

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How Can Scientists

E. V. MURPHREE

THE SPECTACULAR GROWTH of scientific research and technology in the past thirty years—approximately the course of a single generation—has led to vast changes in the lives of people all over the world. At the same time the great outpouring of new technical information has posed a staggering question for the architect of this progress — the technical man: In an age of such rapid technical development, how does he keep from becoming technically obsolete?

Let me offer just a few statistics to define the dimensions of this growth of science and technology.

In 1960 upwards of $12 billion was being spent on research and development in the United States by colleges and universities, by government and by industry. Today's research expenditures are four times what they were just ten years back, and many times what they were in 1930. All indications point to a continued rise, with some estimates placing the annual research outlay ten years from now at $20 billion to $25 billion.

Paralleling this growth has been the increase in the amount of scientific knowledge accumulated in the course of the past generation.

The American Chemical Society's *Chemical Abstracts* for the year 1930 consisted of just three volumes containing about 32,000 abstracts of published chemical information. In 1959 there were seven volumes containing close to four times as many abstracts. And the contents in 1960 have been running 10% greater than in 1959.

Another gage of growth can be found in the publishing field. There were 30,000 scientific, technical and trade journals produced periodically in 1930 around the world. Today there are 60,000. There has been an even sharper rise in the number of scientific books. U.S. publishers brought out 4200 literary books and 800 of a technical nature in 1929. Last year the figure for literary works was 4500 — up 7%. The figure for technical books was 1800 — an increase of 125%.

The figures are awsome enough, but there are other factors besides sheer growth which make it difficult for the technical man to keep abreast.

Today, for example, both the chemist and the engineer work in broad areas, and must know more of each other's field than ever before. Both also must have a working knowledge of mathematics, physics and other fields. The work going on today in the government's space exploration program is a good example of how various disciplines are blending, involving as it does basic and applied research in physical sciences as well as engineering.

Electronic tools today give better and more accurate data in a shorter time, but these devices contribute to the problem of human obsolescence, too. A man has to keep posted on such techniques.

The rapidity with which whole fields of technology change is still another element. Men who invest time and thought in solving one set of problems may find their objectives changing along the way, as developments outside their work create new problems.

The hard kernel of technical learning originates in colleges and universities, and they have done a fine job of tailoring and retailoring their curricula to meet changing needs. There has been an increase in the emphasis schools are putting on theoretical study, as opposed to practical work. For the engineering student, for instance, the one-time concept of "handbook engineering" has virtually disappeared. For the chemistry student, there is far more exposure to the fundamentals of physics, mathematics and engineering in the past.

There has also been a heartening emphasis on advanced study by young people interested in the physical sciences and engineering. For a man to be well rounded in science and technology today, the need for graduate education is very real indeed. I was interested to note recently that U.S. schools have conferred more than three times the number of advanced degrees in the past thirty years than they had granted in the previous seventy.

A solid education, of course, is only the beginning. It is the learning that comes after school which prevents the malady of obsolescence in technical people. What can the technical man do for himself in this regard?

To begin with, he must realize that keeping himself aware of the pertinent happenings in the world of science is his personal responsibility. It has been said that science is not an activity that goes on in laboratories but rather is an activity that takes place in the mind. The technical man who doesn't keep up with his contemporaries is betraying himself and his profession.

Next, he must accept the fact that no man can master more than one general field. Science and technology have become simply too broad, too comprehensive.

Last, he must recognize the absolute need for continuing to broaden his knowledge — both in his own and in related fields — but without letting his basic tools of knowledge, the fundamentals, grow dull. New developments may come with dizzying speed, but the fundamentals change scarcely at all.

In order to keep himself abreast of new developments, new concepts and new technical tools, the perceptive individual quickly learns the value of being an omnivorous but selective reader. He learns the mechanics of getting information — that is, where to obtain facts, whom to ask for specialized knowledge, what technical meetings will be most productive for him, what facilities for advanced study are available, etc. Finally, he seeks to widen his acquaintance among other people doing technical work, particularly in different fields.

There is much each man can and should do for himself to guard against obsolescence, but of course he cannot do all of it alone. The top echelon of management bears a supplemental responsibility.

Are those of us in management positions doing enough in this respect? I suppose we can never know for sure. Let me review briefly some of the things that I, as one man in management, feel are important aspects of this responsibility.

FIRST, and basic to all points to follow, management has to help the industrial research man grow by offering him challenging work — work that will stretch his brains and tempt his intellectual powers. Giving him a stulti-

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EDITOR'S NOTE: This article is an adaptation of a recent address by E. V. Murphree to the American Chemical Society. Mr. Murphree is president of Esso Research and Engineering Company, the Jersey Standard affiliate. The condensation was first published by *The Lamp*, Jersey Standard magazine. The subject is one that concerns every scientist or engineer and his company.

Keep Up With Science?

fying assignment is the quickest way to produce a technically obsolete man.

SECOND, in research organizations of appreciable size, thoughtful management provides for people on the staff who are or who can become authorities in fields connected with the company's endeavor. A polymer rheologist, say, or a man who specializes in the mechanism of controls, particularly in the theoretical aspects, can be invaluable to other members of the technical staff. The establishment of such experts, especially in new fields, often requires sending employees back to school to take special courses under leading authorities.

THIRD, in the belief that no technical man can ever afford to stop learning, management can make available to its technical people the means for further and continuing formal education. Graduate-level courses in various fields of chemistry, physics, mathematics and the like can be of particular advantage —when arranged for by the company and in the company environment, but led by outside specialists who bring a fresh viewpoint to the group. Such courses provide the basis of understanding for people who would otherwise have difficulty in following new and complex developments in their technical reading.

FOURTH, a capable staff of technical consultants from universities and independent research organizations, representing a wide range of fields, can do much to keep employees informed about new developments. Management not only should provide for such a staff but should make sure that employees down the line are exposed to this beneficial outside experience and thinking. Incidentally, this works two ways. A good interchange of ideas can't help but benefit consultants, too. A related effort that can be equally productive is to invite guest speakers to come in from time to time to tell technical groups about new areas of interesting work going on elsewhere.

FIFTH, management should pay close and continuous attention to its internal system of handling technical information, including material originating both inside the company and out. A good system, along with an efficiently operated and well-stocked technical library, can do much to combat obsolescence. It should also be made patently clear — down to the newest technical man—that such facilities are available to all and should be used fully. In view of the shortage of top-flight technical people today, failure to use available literature—and, by reason of the failure, to do unnecessary work—is certainly to be avoided.

There are other things management can do. Technical people should be encouraged to participate in a reasonable number of technical and scientific meetings. They should be urged to publish their work when it is worth while, but dissuaded from flooding the literature. They should be left unencumbered by administrative duties that are not altogether essential. Finally, they should be adequately rewarded for technical achievement, in terms of both money and recognition, since such rewards can be a strong stimulus.

It is sometimes overlooked that members of technical management face the same threat of obsolescence. To some degree, they are even more vulnerable to this danger than the men working in the laboratories.

Time is the executive's biggest enemy in this regard. His day has no more hours in it than anyone else's, yet he must concern himself with the functioning of the entire organization. Policies, budgets, recruiting programs, personnel problems—to mention just a few—all intrude on the over-all job of planning the technical effort. There is precious little time left over to devote to his own technical education.

Compared with the men working for him, the manager's need for knowledge in fields other than his own is less acute in specific detail. But it is more acute in the broader sense. For example, I feel that I should know something about computers and how they can be applied in engineering and research. I also feel I should have a speaking knowledge of the mathematical techniques that have been developed for determining the frequency response of systems. By the way, these methods have been successfully adapted to determining the flow characteristics of various types of process reactors. I could mention many other examples, such as new developments in energy conversion devices, but the point I want to make is that new fields of study have got to be generally understood by managers — no matter how long they have been away from direct research—if they are going to provide intelligent guidance to the technical staff.

How a management man does this I can't say specifically. I have no formula of my own to offer. There are the obvious things: more delegation of administrative routine, wider participation in meetings of professional groups, "smarter" reading, more direct contact with the work being carried out in the organization and with the people doing the work. Basic here also is a wide acquaintance with people in many divergent technical fields.

The main point is that *the technical man who moves into a technical management position can never afford to stop being a technical man*. He has not graduated to a new profession, really. What he has done is to extend his profession to include new types of problems. And he must never let his original field become strange and mysterious to him.

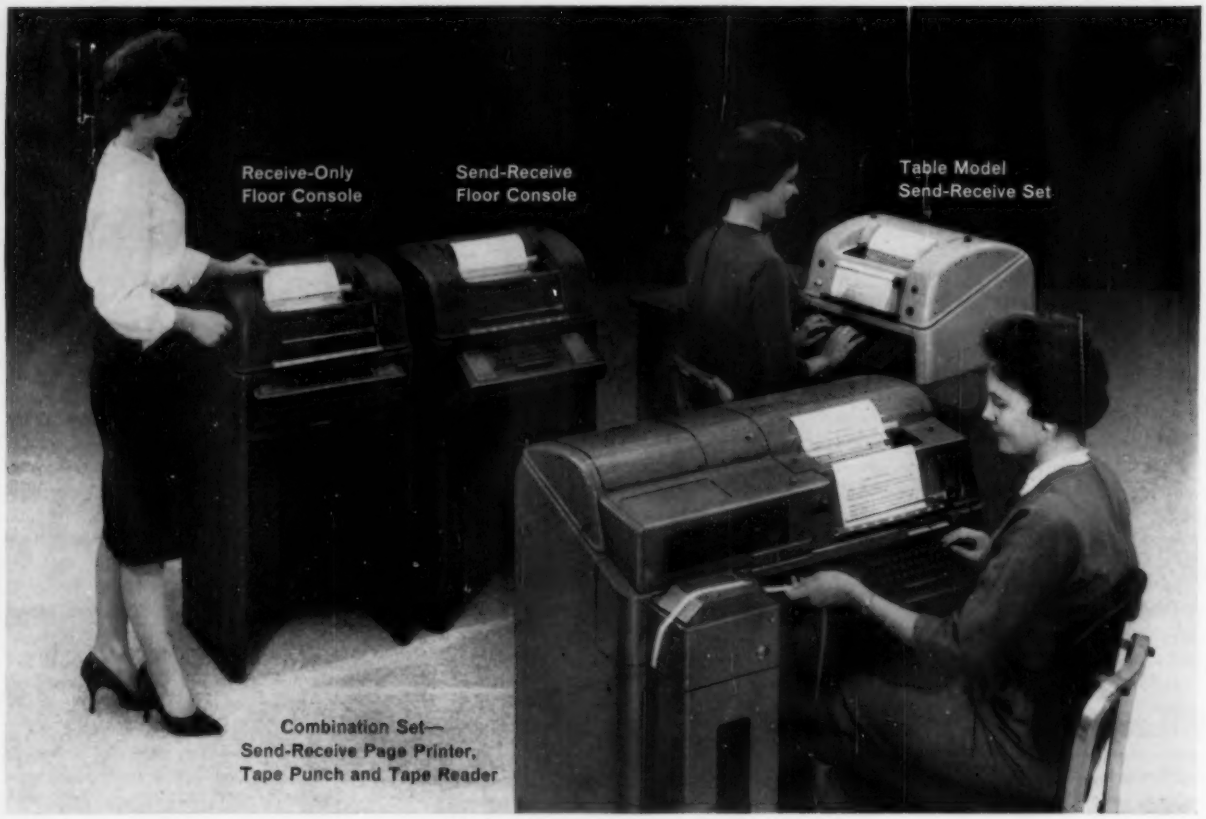
In concluding, I would like to suggest that every technical man—regardless of the position he holds or the field he works in—has an obligation today that goes far beyond himself, his colleagues, his employer, even his family.

Technology has taken its place as a vital growth force in the economic system the world over and is considered by many economists now to outweigh in significance the traditional factors of production—land, labor and capital. Thus the technical man is not just another soul working to make a living. In a world that relies increasingly on scientific advancement, he is the builder of the future.

It is not old-fashioned or unreasonable, I think, to expect the technical man of today to be dedicated to his profession. He has inherited the wealth of past scientific accomplishments, and he cannot take his responsibilities to his scientific ancestors—or to his heirs —lightly.

He exists, in a sense, to carry out what an economist recently referred to as "creative destruction"—he works to make technology obsolete.

But he doesn't let the same thing happen to him. ★ ★ ★



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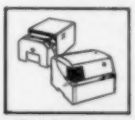
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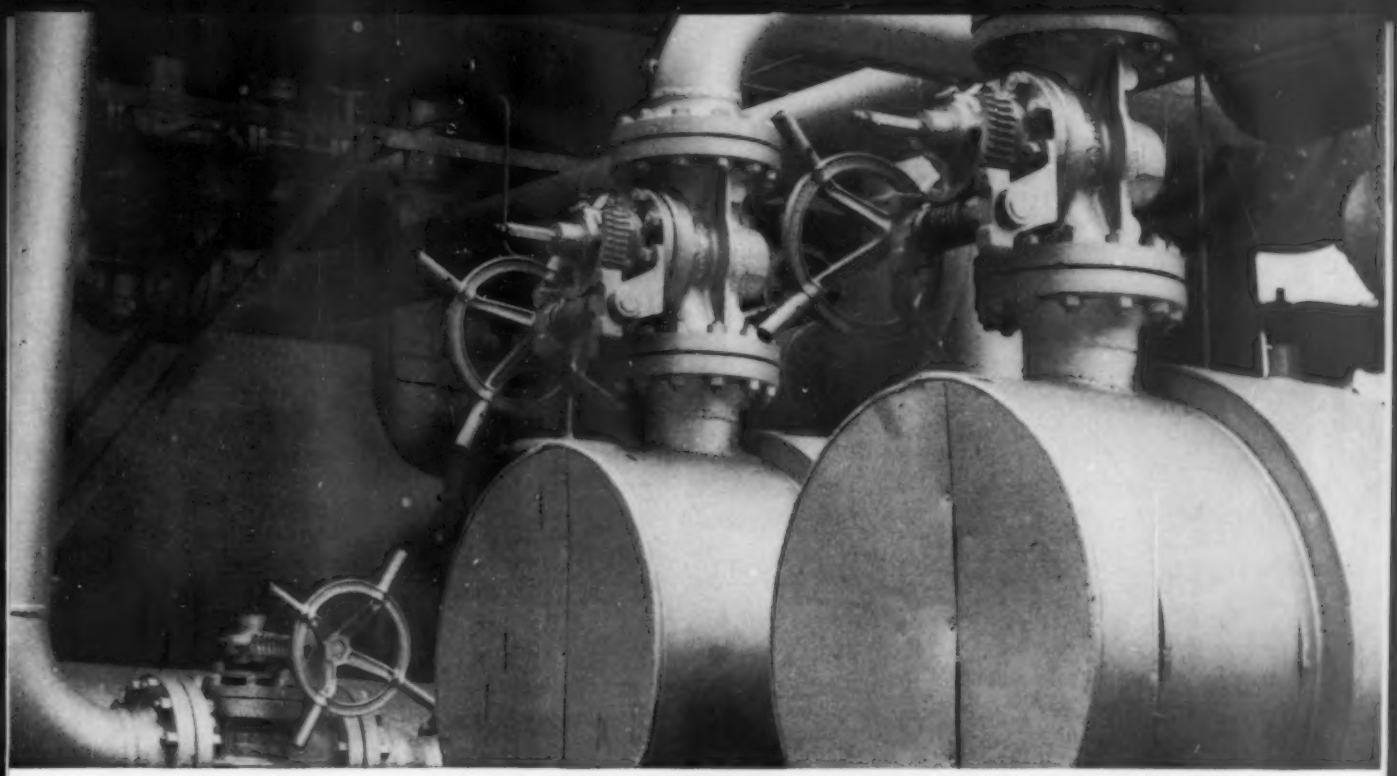

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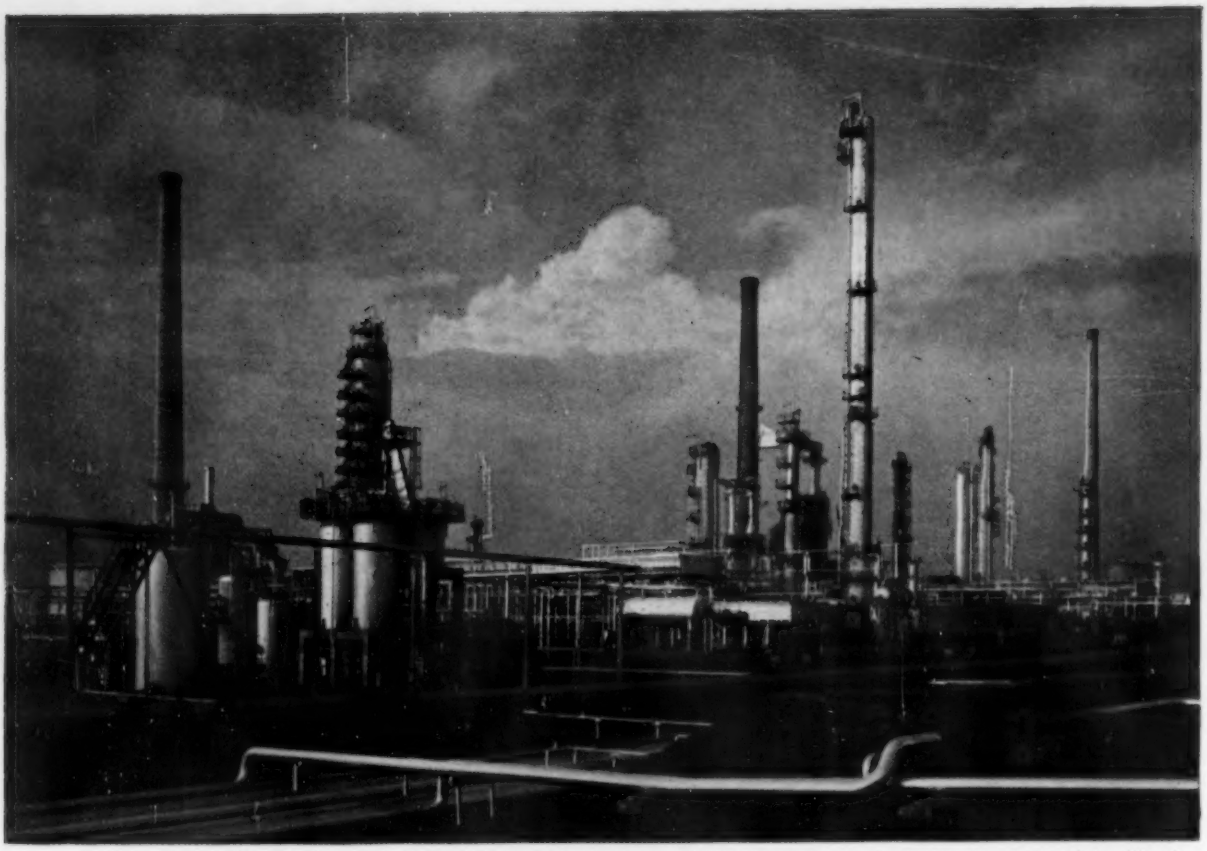

Esso Petroleum Company, Limited, 100,000 BPSD refinery at Milford Haven, Wales. Engineering-contractor: Foster Wheeler

The Invisible 100,000 BPSD Refinery

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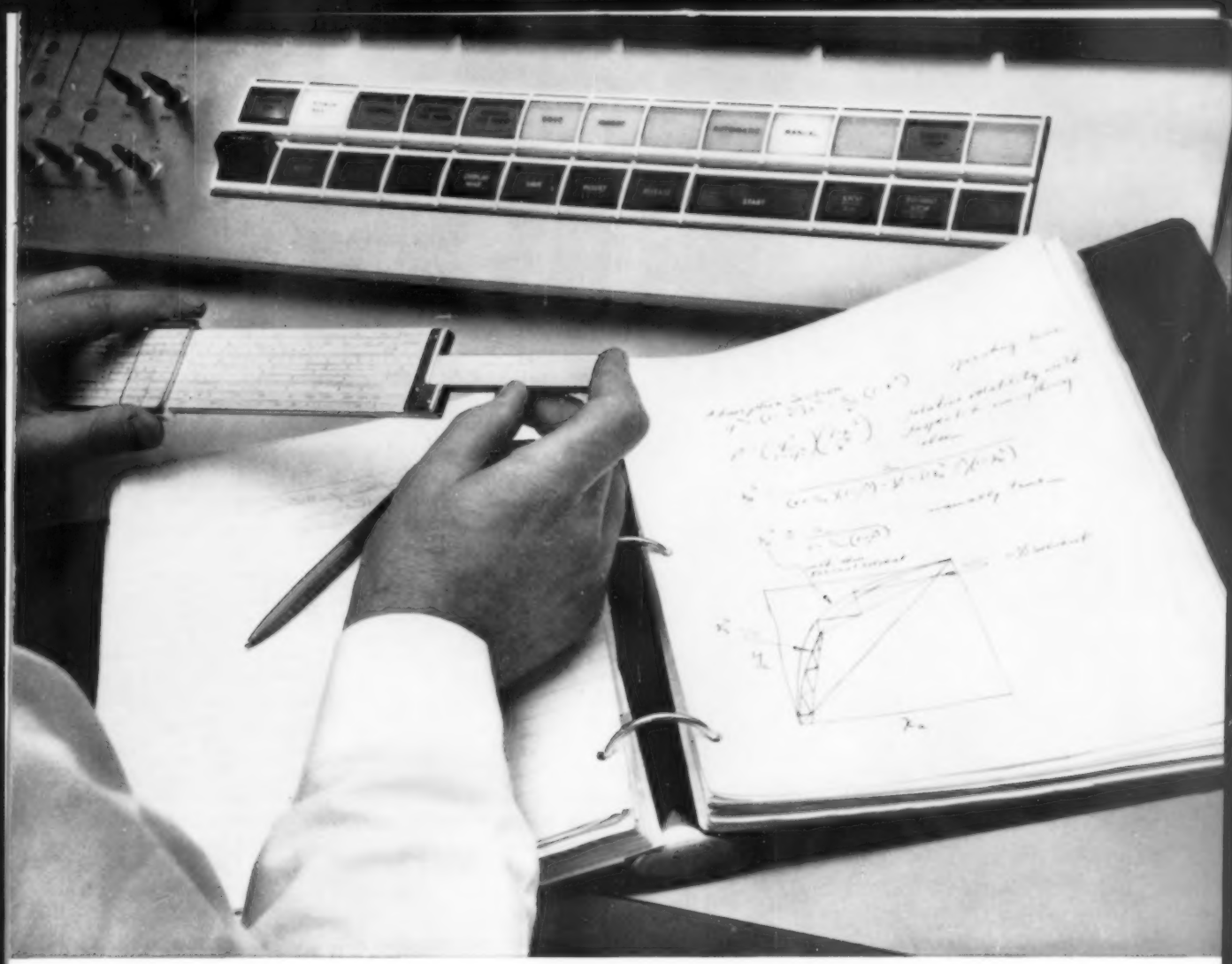

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A major breakthrough in unified engineering between process designers and fabricators, the plant went on stream in less than three and a half months from the day of ground breaking. This amazing record was achieved by having the complete facility factory assembled, tested, skid mounted and shipped to location ready to go on stream with only interconnecting piping and outside of the building items left for final assembly at the job site.

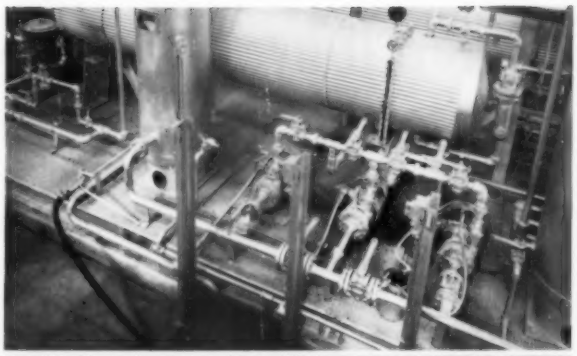
Process engineering and field installation was performed by O. L. Olsen Company, Inc., with the J. B. Beaird Company, Inc., serving as the single source of responsibility for engineering assembly, purchasing and fabrication of pressure vessels and packaged plant components.

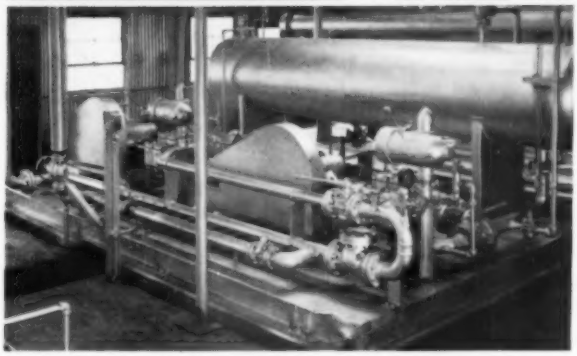
The entire operation is built around eleven skid mounted units. Three of these are 660 horsepower Beaird-Ingersoll-Rand packaged compressors, with eight skids handling the entire gas processing system. Each skid unit serves multiple process functions which were grouped by Beaird engineers for economy and convenience of interconnecting piping and fabrication.

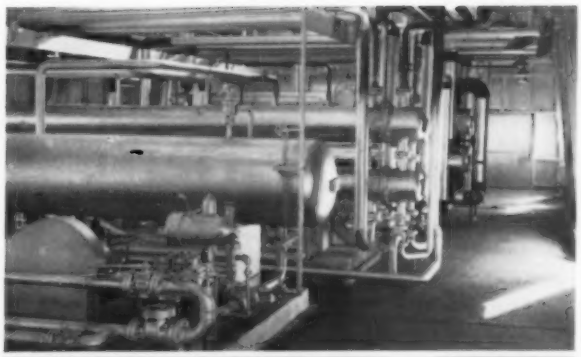
Packaging of the plant effected major savings for Antelope Gas Products. Much of the normally costly field labor and installation time was eliminated. A simplified building and foundation met all requirements. Hauling and shipping costs were lowered. And should the plant be moved at some future date . . . everything except the foundation can be salvaged.

When your next gasoline plant is still in the planning stage . . . let a qualified Beaird engineer show you the savings possible through factory assembly and packaging of the process functions. *Contact your nearest Beaird representative or write direct.*

Antelope Gas Products' Harry P. McClintock (Managing Partner) won out over severe Nebraska weather and an isolated location with his plan for a factory assembled gasoline plant.



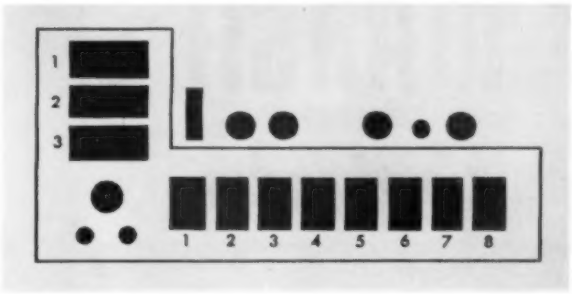




EACH SKID UNIT HANDLES MULTIPLE PROCESS FUNCTIONS

1 Grouping of components on skids was determined by convenience and economy of piping as well as related process function. Skid 2 contains depropanizer and debutanizer relux accumulators and their pumps. Not shown, but overhead on the skid, are the condensers. Other units include a stripping steam generator and a depropanizer reboiler.

2 Lean oil pumps, surge tank and pulsation dampeners are mounted on skid 5.



PACKAGING SIMPLIFIED PLANT LAYOUT

3 From the center of the Process building, skids five through eight can be seen. Packaging of the units made possible the clean schematic layout of the entire plant. Interconnecting piping and product lines are located overhead, leaving an uncluttered walkway around all sides of the units. This arrangement promotes safety, simplifies maintenance and encourages good housekeeping.

SINGLE RESPONSIBILITY REDUCED PLANT COSTS

4 Beaird handled complete purchasing, fabrication and engineering assembly of all pressure vessels and skidded plant components. 270,000 gallons of storage and four towers were included in the thirty-three pressure vessels fabricated by Beaird. Unified engineering and purchasing effected substantial savings for Antelope Gas Products.

BUILDING BLOCK PLANT LAYOUT

Economical installation and simplified construction of the plant building were made possible by packaging of the process units. Skids one thru three are 660 horsepower Beaird-Ingersoll-Rand Packaged Compressor Plants. Skids four thru eleven handle all process functions. Four Towers, an oil reclaimer and a process oil tank are located in the ell formed by the compressor and process buildings.

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A subsidiary of American Machine & Foundry Company

SHREVEPORT, LOUISIANA

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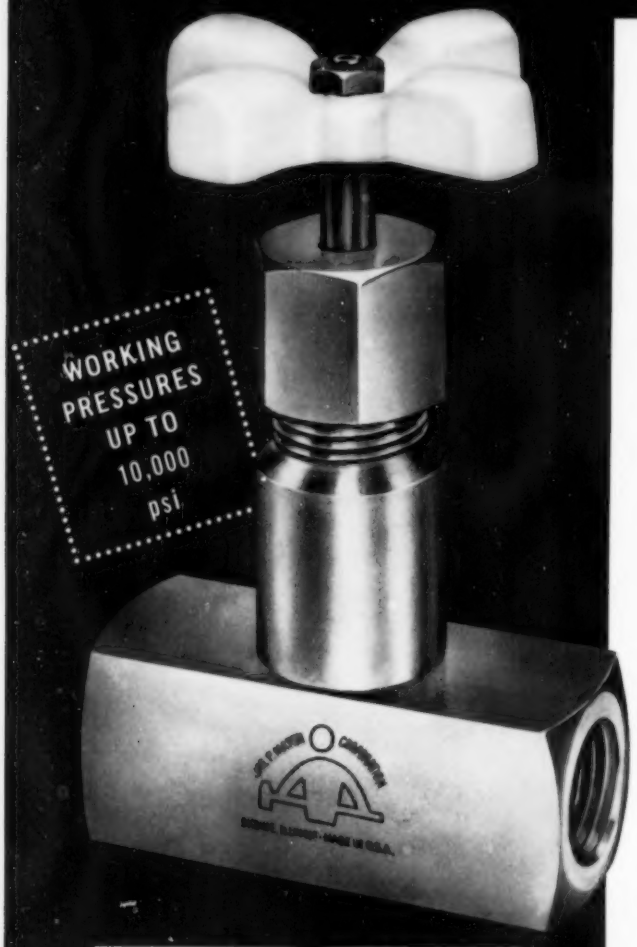

Know it by the yellow handle

Use it because it embodies features never before combined in a needle throttling valve...

It is the first throttling and shut off valve that serves the whole range of pressures—from low to 10,000 psi—with equal efficiency all the way through.

It is the valve in which body and stem guide are one piece—completely fused into an integral leak-proof unit by the exclusive Marsh "Conoweld" process.

It is the valve in which the stem is precision machined and ground. Perfect stem alignment and fine threads provide easy and precise throttling. Special "Marpak" packing always holds tight; never binds.

Bodies of the 1900 series identified by the yellow handle are machined from high grade carbon steel bar stock marked in accordance with M.S.S. regulations showing size, material and service. Stems are 416 stainless steel. Valves are available in the patterns shown below; sizes ⅛", ¼", ⅜", ½", ¾" and 1".

Marsh Needle Valves are also available in 416 stainless steel throughout (identified by green handles). *Write for bulletins.*

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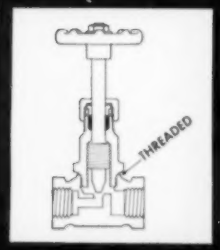
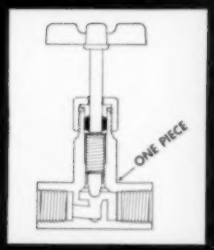
Division of Colorado Oil and Gas Corporation

Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta
Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas
Eastern Seaboard Warehouse: Marsh Instrument Company, 1209 Anderson Ave., Fort Lee, N. J.

In stock at your nearest Supply House



Conventional Construction



Marsh Construction

In conventional valve (left) stem-guide is threaded into body... can be backed out when valve is fully opened, causing real trouble when pressure is high. Can't happen with Marsh design (right). Marsh stem-guide is welded to body.

MARSH

SERIES 1900

Needle Valves

GREECE OIL OPERATIONS PULLING UP ALMOST BY BOOTSTRAPS

ERNESTINE ADAMS
Management Editor

SOUTHEAST OF ATHENS at Lavrion, workmen are leveling off a site for Dow Chemical's million-dollar polystyrene plant. Foster Wheeler Italiana has the construction contract. Dow Hellenic Chemical will be the operating company that makes and sells plastics and provides technical service.

This is another "first" for Greece — the first polystyrene plant.

Greece has had an encouraging number of "firsts" in business and industry since the war was finally over for them.

Long after World War II, when the Greeks bravely held off the Italians, patriots fought and died against Russia's determination to take the little country. Never rich in resources, the struggle drained the national wealth. The fight for economic progress made some headway, for now the bright and hopeful eyes of 8,600,000 Greeks are on the future.

The lovely capitol city of Athens, with its Acropolis crown, is the home of 1,600,000 people and has a concentration of industry. Oil consumption figures show that about 60% of all oil products are sold in the Athens area.

In 1955 the Greek government decided to build a refinery and in time awarded a German subsidiary of Hydrocarbon Research, together with Krupp and Stahlunion, the contract for construction of a 30,000 b/d refinery at Aspropyrgos near Athens.

After the refinery was completed in 1958 a local operating company was formed called Oil Transport, Trading and Refining Company which took a 10-year lease on the refinery. This company was succeeded by Hellenic Petroleum Refineries Company, which is owned 71% by Stavros Niarchos, the shipbuilding tycoon, 10% by National Bank of Greece, 10% by Socony Mobil, 5% by St. Syziotis, and 4% by D. Karapanos (Hydrocarbon), general manager of the company.

Mobil Petroleum Supply Company was formed to buy the crude oil for the refinery as Greece has no production. This company pays processing fees to the refinery and owns the products that come from processing. Distribution of products is made in proportion to companies' demand in Greece. Mobil, Shell and BP each have about 20% of the market, Purfina about 12% and others about 28%.

This does not include the crude oil supplied by the Greek government for its own requirement. A stipulation in the lease agreement provides the State shall have the right to supply crude in proportion to the refinery's

J. E. Mohundro and C. Askitopoulos, plant manager and assistant, at the Aspropyrgos refinery near Athens.

throughput — as much as 30% of the designed capacity. Since the refinery's designed capacity is 30,000 b/d the government provides 9000 b/d crude oil, which comes from Eastern Block sources under a bi-lateral trade agreement. Actual runs are now 36,700 b/d.

The refinery itself is compact, modern, well laid out and efficiently run. Besides the crude units it has Atlantic reforming and vacuum units, copper chloride treatment, asphalt units, 5000 kw power, and 250,000 cu meters tankage (80,000 cu meters more tankage being built.) A new 1500 b/d LPG plant is going in and will be ready by July or August. More expansion is in prospect and plans may now be firmed up. J. E. Mohundro, who came with Hydrocarbon Research, Inc. in 1958, stayed on to manage the plant. C. Askitopoulos, who attended Rensselaer Polytechnical and has worked in the United States with Monsanto, is assistant.

There are 600 employees at the refinery; all except 21 are Greek nationals. Mohundro said there were plenty of well-educated people to employ. The company hired a number of engineers and chemists from University of Athens and Athens Polytechnical and gave them intensive on-the-job training.

The crude is unloaded at Megara and is pumped to the refinery, a distance of 16 miles, by a 12-in. pipeline.

Refinery output is distributed roughly as follows: 50% is loaded on tankers from refinery sea terminal; 30% goes by pipeline to the installations of various marketing companies; and 20% is hauled by tank trucks.

Another plant, the Elbyn Lubricating Oil Refinery, near Piraeus, makes lubricants. Plant capacity is 400 b/d. President and general manager is George Ch. Syrenghelas.

The Naphtha Refinery of similar capacity processes naphthenic crude for use in lubricants.

Consumption of fuels in Greece, excluding international bunkers, is about the same as refining output, some 37,000 b/d, except for diesel oil, which is imported at the rate of 3800 b/d, and aviation fuels, of which 2000 b/d are imported.

One oil product — kerosine — is a monopoly. The Greek government controls its sale, distribution and importation. Only five commodities are subject to monopoly, including salt and matches.

John C. Bliss: "Indications point to steady growth, particularly if Greece joins Common Market."

John C. Bliss, president of Mobil Oil Hellas and Mobil Petroleum Supply, says that gasoline is only 10% of the total consumption. There are only about 80,000 vehicles in Greece, approximately half cars, the remainder buses, trucks, etc. Most of them are in Athens. He added, however, that in 1960 the increase in gasoline was probably 10% and the estimate is for a 35% rise in five years. Trucks and buses, some power plants, farm machinery, etc., use diesel oil.

L. Vacratsas, general director of the State Service for Control of the Greek Oil Refinery, represents the

L. Vacratsas: "The $24-million refinery will be paid for out of profits in another two years."

government and deals with the refinery operating company. His technical adviser is Richard T. Stahl of George Armistead and Company, the consulting firm for the refinery design. I asked Mr. Vacratsas how much profit the refinery made and he said about $10 million a year. Amortization comes from this, however, and it will take about two more years to pay for the government refinery. The State paid only 15% down on the $24 million plant. The remainder is paid out of profits.

The operating company gets 9.5% of the net income from operations but this is reduced by half after taxes.

Representative of Mr. Niarchos on the board of the operating company is Stephanos Syriotis. Mr. Syriotis said that the refinery saves the government about $13 million a year in foreign exchange which is the difference between importing products and importing crude.

A new oil law following the 50-50 formula, was enacted in April 1959 to attract explorers. The country is

Stephanos Syriotis: "Refinery saves Greece about $13 million a year in foreign exchange."

not considered very promising but a number of concessions have been applied for, some granted.

Esso Hellenic was granted three exploration areas. One on the Islands of Paxi and Antipaxi; a second on the Island of Zakynthos and the Killini area on the mainland of Peloponnesos, and, third, in the area of Pylos. Total extent of the concessions is 988,000 acres, including offshore. Esso is to invest $6,400,000 in eight years.

C. D. Alworth was sent from Libya in July to set up the organization for Esso's operations in Greece. Kellogg Overseas Corporation (Fred Williams, local manager) has a contract to drill. Mr. Alworth said that plans to select a site would depend principally on surface geology findings. Some seismic work is being done in covered

C. D. Alworth: "We are selecting a drilling site principally on surface geology findings."

areas where no outcrops exist as well as to check some structure features.

BP Exploration Company, Ltd., and the National Bank of Greece formed the Aetolian Oil Company S.A. and BP Exploration formed BP Exploration Company (Greece) Ltd. Aetolian obtained exploration rights in the islands of Cephallonia and Lefkas and on the mainland in Aetoloakarnania. All the exploration and exploitation rights granted to Aetolian have been transferred to BP Exploration (Greece). These concessions cover approximately 1,412,750 acres. (During the first eight years BP will spend $7,714,000.)

D. F. Armstrong was recently moved to Athens from BP Austria to manage operations of the above companies and BP of Greece Ltd.

Hunt International, represented in Greece by Edwin D. Guinn, has been awarded 1.2 million acres in the districts of Salonica and Katerini. About 400,000 acres of Hunt's

concession cover seas. Expenditure obligations are the same as Esso Hellenic, nearly $6½ million in 8 years. The concession agreement was executed on September 22, 1960 in Athens and is now awaiting Parliamentary ratification with the British Petroleum agreement.

Ilios, a Greek company, in partnership with Regie Autonome Francaise de Petroles (RAP), has a concession in Western Thrace near Orestias. Recently a new wildcat was spudded.

The new petroleum law says that the State may either grant the right to prospect and exploit its hydrocarbons or may do so itself. Under the latter section these exploration activities are being carried out for the account of the Greek State:

(1) French Institute of Petroleum is searching in the area of Karditsa (Thessaly) for natural gas deposits.

(2) Rumanian State Organization "Industrial Export" is exploring in the Karditsa-Grevena area.

The government expects to establish the Oil Exploration Corporation to handle all petroleum operations.

In two to three years private concessionaires must release 50% of their holdings, in the next three years another 25%, in the next three the remainder, if there is no oil.

Greece will get a more thorough exploring than ever before. There has been little previous drilling. W. G. Helis, New Orleans independent, received an exploration permit in 1953. C. Dielmann Bergbau carried out exploration work in Thrace on Ilios Company's concession, drilling four wells, all dry. American Grecian Oil Company (two Israeli contractors) did some strat drilling in the island of Zante off the west coast.

The government offices directly in charge of the refinery are the Ministries of Coordination and Industry, the latter being also in charge of the concessions. The present Minister of Coordination is Mr. Aristides Protopapadakis and Minister of Industry is Mr. Nicholas Martis. These two are final government authorities on all oil operations.

Minister Martis: "Industry is expanding, which will accelerate demand for oil products in Greece."

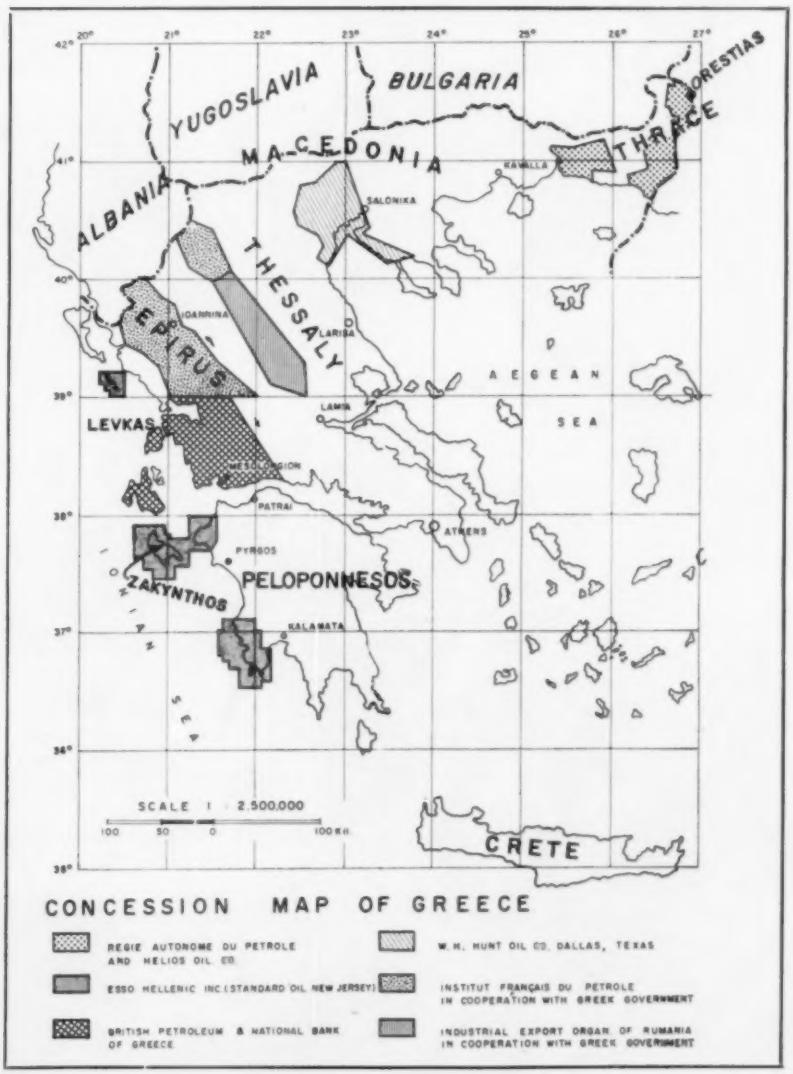
In an interview with Minister Martis and General Secretary of the Ministry, Mr. N. D. Farmakidis, the two agreed that consumption will increase at a higher rate than 5% a year, although the latter figure is the consensus. Mr. Martis pointed out industry was growing in the nation, which would accelerate demand.

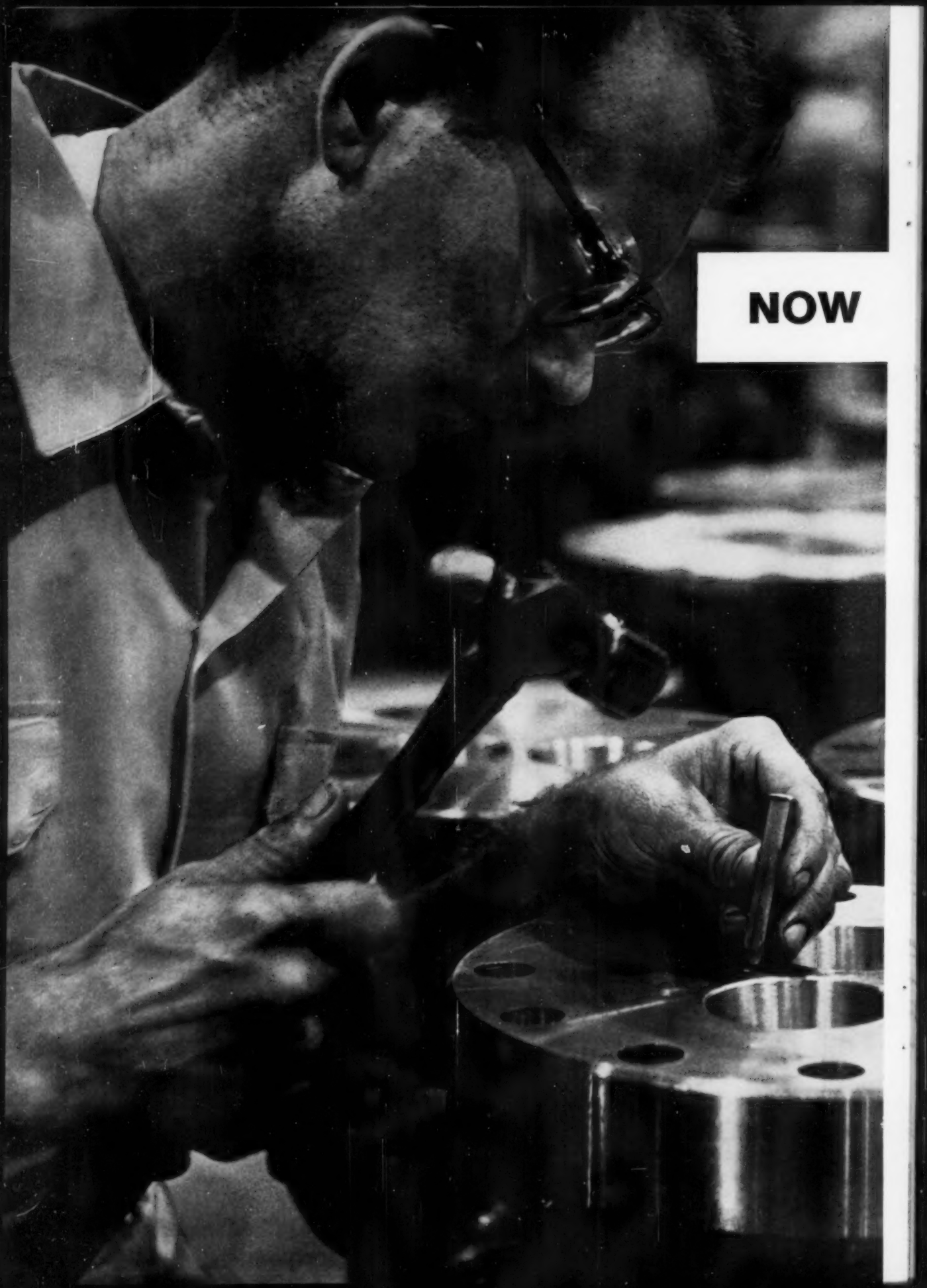
A fertilizer plant is being constructed by the State in Macedonia. At the beginning this was to cost about $25 million, but it will probably be double that before it is completed. There is a new aluminum plant planned by Pechiney (French), 50%; Mr. Niarchos, 21%; Reynolds, 17%; and Industrial Development Corporation, 12%. Sugar and textile mills and cement plant are being added. Of course, the Niarchos shipyards are one of the largest contributors to the Greek economy.

Agriculture is an important industry. Tobacco, cotton, olives, raisins, currants, figs, are grown and exported. Some are traded for Communist oil. Right now Greek economy is stimulated by tourism and plans are set to attract more tourists. Greece has the show places of its fascinating ancient history and an inviting climate.

What is the future of petroleum industry here?

Here is what Mr. Bliss replied: "All indications point toward a steady economic growth, particularly if Greece is admitted to the Common Market. Total petroleum consumption should be well over 20,000,000 bbl (55,000 b/d) annually by 1970." ★

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WHAT MADE OIL PROFITS GO UP?

Disadvantages:
Slower economy ●
Easier crude prices ●
Higher wages and salaries ●
Cut in Texas producing days ●
Increased taxes ●

THE PETROLEUM INDUSTRY is walking briskly up the curve. An indicated gain of 9% in earnings for 1960 and double that — or 18% — for the fourth quarter backs up our statement in "Outlook" (January) that the industry is the leader in the nation's economy.

What has put oil and gas business ahead when the overall picture is pretty bleak?

First place we'd give to improved efficiency and reduced costs. Revenues in 1960 went up only 3% over 1959 so better profit had to come from savings.

Second, increased earnings from petrochemicals and natural gas.

Third, the weather at the end of the year.

Fourth, firmer product prices than in 1959.

Fifth, higher volume.

Many companies made their all-time record for income, but at the other end of the line, some showed a big drop from 1959.

Phillips Petroleum's release said chemicals, natural gas and Venezuelan crude oil, along with continued efforts toward the reduction of unit operation cost, contributed toward making 1960 its record year.

Atlantic Refining's sharp rise in the second half to the highest for any similar period were "the reflection of the strengthened internal position of the company" which meant improvement in crude oil self sufficiency, more profitable mix of products, and important reductions in operating expenses.

Highest net from operational revenues in Gulf's history was significant because the improvement over 1959 came entirely from operations in the United States. In the last 10 years annual rate of Gulf's growth in its year's operations equals 10.6%.

American Petrofina recovered enough in the last half earnings to gain a 21% increase for the year. This rise reflected an improvement in petroleum product prices, operating economies and concentration on investments with quick pay outs, the company reported.

Standard Indiana reported, "Contributing to the record total was the largest product sales volume in the company's history. New highs were also established in the sale of natural gas." Standard profit gain for the last year was achieved in the second half, and "was largely attributable to some improvement in the depressed product prices that existed in 1959." Economies arising from the company's program of cost reduction continue to be a factor in the company's better earnings.

Rise in the Sinclair net was said to be "results of the company's planned program of reduction in costs and expenses, a new high in total sales and a substantial increase in earnings from petrochemical and natural gas sales."

Most important factor of Jersey Standard's 9% rise was the world-wide increase in petroleum products sales of about 5%. Continued emphasis on control of operating costs, gains in sales of petrochemicals and natural gas were also mentioned.

Jersey is mindful, too, of its increase in government payments: "Income and operating taxes, together with import duties, consumer taxes and other payments to the United States and foreign governments, are estimated at more than $2,590,000,000 for 1960. The comparable total for 1959 was $2,518,000,000."

Tidewater's improved earnings for 1960 were said to be due primarily to increased sales volume and greater operating efficiency.

Socony Mobil attributed the higher earnings in 1960 also to increased operating efficiency, record volumes, and firmer product prices in the United States in the second half.

High ratio of success in the company's drilling efforts was mentioned by Texas Pacific Coal and Oil Company. About 73% of the company's production comes from Texas where only 104 producing days were allowed in 1960 compared to 123 in 1959. Despite this, with a carefully planned drilling program Texas Pacific managed an 8% increase.

Only one to mention the weather was Ashland Oil and Refining which pointed out that extended cold weather began in December and continues into the first quarter of 1960.

Ashland pointed out the substantially reduced demand from steel and other major industries for heavy fuel oil.

Continental Oil said higher crude oil production, a reduction in provision for Federal income taxes and decrease in intangible development costs contributed to earnings improvement. Adverse factors were lower average prices for crude oil and refined products.

Although actual figures for Clark Oil and Refining were not available, a release by that company says that it had an excellent fourth quarter which allowed the company to wind up 1960 with earnings virtually the same as '59.

Commonwealth Oil Refining Company, which has a refinery in Puerto Rico, made a leap forward. In its report Commonwealth refers to its industrial tax exemption but states it contributes to the country through U. S. customs duties on crude oil, which are retained by the Puerto Rican treasury.

Strenuous marketing competition ahead was evidenced in several reports. Shamrock Oil and Gas said it had bought 19 and leased 13 service stations to enlarge its Texas marketing territory. Ohio Oil Company acquired Ross Oil Corporation, Ross Industries, and Auto City Oil Company, all three jobber organizations. Tidewater bought two marketing firms, Pathfinder and Community Stations. Shell said that it was going back into some areas in the U. S. from which it had withdrawn in the past.

There were a number of companies

with earnings lower than in 1959. Colorado Oil and Gas said the first half deficit was due to a sharp and extended decline in refinery product prices. The company recovered some of the loss in the second half.

Reasons for Sunray's net slipping below 1959 were given as heavy proration of crude production by state regulatory bodies and depressed product prices.

General Crude Oil Company suffered also from the record low 104 producing days in Texas. This "coupled with rising costs, tightened the squeeze on profits in the producing segment of the industry." The company did not, however, cut exploration to offset the effects of lower production volume.

Aztec Oil and Gas describes its decrease as due to extended wildcat drilling and exploratory expenses and some drop in oil production. Midwest Oil Corporation also mentioned the increase in drilling cost as well as a small drop in oil revenue.

According to Standard Oil of California "oil industry prospects now are somewhat better than they were a year ago, with an improved relationship between demand, production and refinery runs since this time last year."

Profits as related to gross income rose to 8.8% from 8.0% in 1959, according to these early figures. This is still on the low side for an industry with such high capital needs.

This 0.8% widening in profit margin can easily be erased by the general 5% rise (or 14¢ an hour) in wages. Phillips points out that "Although some prices for finished petroleum products recovered during the last half of the year, this trend must continue if higher costs resulting from the recent general wage increases are to be offset."

Standard Indiana stated, "We are hopeful that these increases (product prices) can be held in 1961 to offset higher wages and other costs."

Says Ashland, "These wage and salary increases will add $1,500,000 to our annual operating expenses. The oil industry can recover these additional costs only by raising prices of refined products."

In January 1960 (Page A-9) our estimate for capital expenditures for the year was 2% higher than 1959. Although all data are not final, present figures indicate that 1960 capital outlays are 2% above those for 1959.

— Ernestine Adams ★ ★ ★

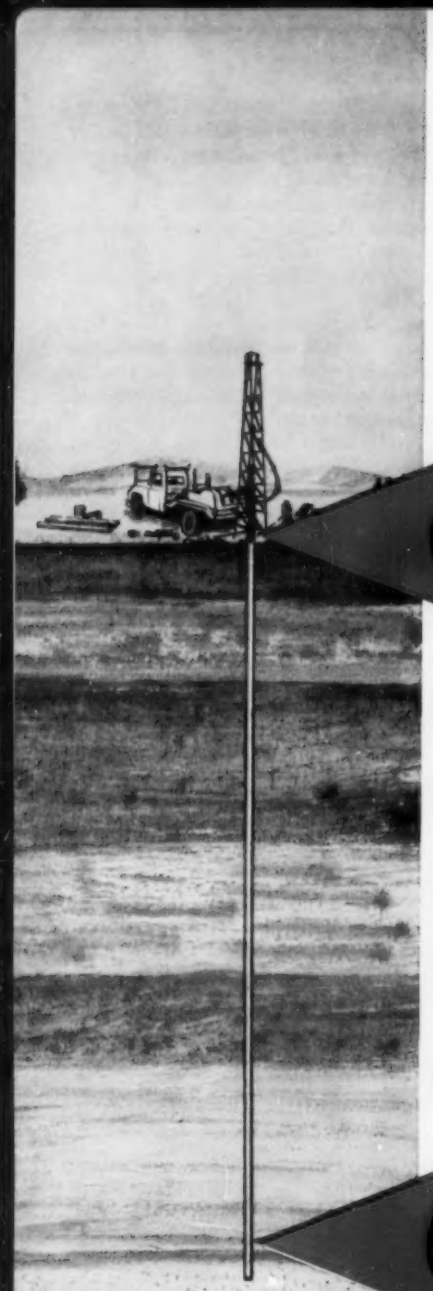
PRELIMINARY ESTIMATED FINANCIAL REPORTS FOR 4TH QUARTER AND YEAR ENDING DEC. 31.

(All in $1000 s)

	Quarter ending Dec. 31						Year ending Dec. 31					
	Gross			Net			Gross			Net		
Company	1960	1959	% Change	1960	1959	% Change	1960	1959	% Change	1960	1959	% Change
Ambassador	1,840	2,103	− 13	46	424	− 90	6,728	6,313	+ 7	1,010	802	+ 25
Am. Petrofina	—	—	—	—	—	—	75,000	76,800	− 2	1,232	1,016	+ 21
Ashland	79,982	80,179	0	3,906	3,627	+ 8	303,476	304,855	0	15,206	14,744	+ 3
Atlantic	150,502	140,043	+ 7	19,161	4,745	+304	561,205	541,274	+ 4	46,566	30,174	+ 54
Aztec	2,140	2,233	− 4	1,071	1,042	+ 3	8,169	8,375	− 2	4,514	5,138	− 12
British American	—	—	—	9,546	10,517	− 9	—	—	—	30,803	25,602	+ 20
Champlin O & R	22,379	20,685	+ 8	3,009	2,403	+ 25	86,208	84,620	+ 2	9,157	8,548	+ 7
Coastal States[4]	5,772	4,210	+ 37	975	698	+ 40	17,586	10,354	+ 70	2,951	1,586	+ 86
Colorado O & G	12,201	11,578	+ 5	1,212	762	+ 59	46,449	45,779	+ 1	1,850	2,527	− 27
Commonwealth Oil	20,710	21,812	− 5	2,951	2,234	+ 32	77,218	71,631	+ 8	6,618	3,135	+111
Continental Oil	202,058	198,912	+ 2	15,797	14,942	+ 6	799,145	786,752	+ 2	61.200	60,300	+ 2
Cosden	20,634	19,593	+ 5	1,364	1,296	+ 5	81,983	84,294	− 3	4,370	5,129	− 15
Delhi-Taylor	—	—	—	—	—	—	98,400	86,600	+ 14	3,600	2,707	+ 33
Frontier	11,219	7,012	+ 60	357	173	+106	40,692	31,652	+ 29	1,765	764	+131
General American	8,064	6,429	+ 25	1,625	1,088	+ 49	30,843	26,093	+ 18	3,208	4,927	− 35
General Crude	—	—	—	—	—	—	12,137	13,461	− 10	2,216	3,367	− 34
Gulf	—	—	—	92,000	73,992	+ 24	3,218,000	3,170,847	+ 1	330,000	290,467	+ 14
Hugoton	1,960	2,123	− 8	910	946	− 4	6,595	7,423	− 11	3,081	3,448	− 11
Kerr-McGee	—	—	—	8,465[1]	3,501[1]	+142	—	—	—	—	—	—
Leonard	14,603	13,297	+ 10	429	274	+ 56	55,890	54,401	+ 3	1,807	1,339	+ 34
Maracaibo	415	432	− 4	42	51	− 18	1,642	1,766	− 7	199	244	− 18
Midwest Oil	5,425	5,487	− 1	2,442	2,404	+ 2	20,716	20,784	0	7,341	7,368	0
Ocean Drlg. & Expl.	2,297	1,909	+ 20	487	86	+466	8,610	6,413	+ 34	1,436	362	+297
Ohio Oil	—	—	—	11,805	11,310	+ 4	—	—	—	39,215	38,633	+ 2
Phillips	323,000	297,000	+ 9	33,500	27,253	+ 23	1,225,000	1,179,247	+ 4	112,400	104,639	+ 7
Republic Nat'l Gas	9,079	8,542	+ 6	3,039	2,647[6]	+ 15	—	—	—	—	—	—
Shamrock[3]	16,885	13,643	+ 24	3,254	2,233	+ 46	65,935	57,057	+ 15	10,457	9,182	+ 14
Shell	—	—	—	40,272	43,363	− 7	—	—	—	144,580	147,418	− 2
Signal	—	—	—	—	—	—	304,000	194,000	+ 57	16,500	16,250	+ 2
Sinclair	—	—	—	18,000	10,500	+ 70	—	—	—	52,400	45,000	+ 16
Socony Mobil	—	—	—	46,600	41,000	+ 14	—	—	—	182,500	164,000	+ 11
Standard (Calif.)	487,000	458,354	+ 6	67,000	73,484	− 9	1,921,000	1,794,695	+ 7	266,000	253,599	+ 5
Standard (Ind.)	529,700	488,202	+ 9	41,900	33,408	+ 25	2,038,000	1,980,779	+ 3	144,750	139,597	+ 4
Standard (N. J.)	2,298,000	2,219,000	+ 4	187,000	153,000	+ 22	8,890,000	8,714,000	+ 2	688,000	630,000	+ 9
Standard (Ohio)	104,942	99,977	+ 5	7,088	7,101	0	402,443	396,638	+ 1	24,662	25,061[6]	− 2
Sun	207,418	178,800	+ 16	14,421	10,694	+ 13	755,426[2]	746,265[2]	+ 1	49,273	42,844	+ 15
Sunray Mid-Cont.	119,000	110,000	+ 8	12,000	13,000	− 8	463,769	450,989	+ 3	41,121	43,815	− 6
Superior Oil[3]	35,343	28,286	+ 25	5,621	2,922	+ 92	165,877	160,203	+ 4	27,223	22,278	+ 22
Texaco	—	—	—	112,766	92,492	+ 22	—	—	—	391,750	354,346	+ 11
Texas Gulf Prod.	—	—	—	—	—	—	—	—	—	4,400	4,189	+ 5
Texas Pacific	6,543	6,549	0	2,019	2,014	0	26,234	26,149	0	7,778	7,197	+ 8
Tidewater	148,319	143,969	+ 3	3,649	6,109	− 40[5]	583,000	559,442	+ 4	35,000	33,941	+ 3[5]
TXL[3]	3,074	3,030	+ 1	900	916	− 2	12,505	13,040	− 4	2,855	4,072	− 30
Union Oil Calif.	134,400	131,289	+ 2	10,700	7,615	+ 41	535,600	512,962	+ 4	34,400	27,515	+ 25
Wilcox	—	—	—	260	315	− 17	5,961	7,081	− 16	840	983	− 15
TOTALS	4,984,904	4,724,678	+ 6	785,589	666,581	+ 18	22,951,443	22,233,034	+ 3	2,816,234	2,588,253	+ 9

EDITOR'S NOTE: In some instances fourth quarter figures are ours, calculated from estimates of third quarter and annual figures.

[1] For 6 mo. ending Dec. 31.
[2] Include $4,463,000 capital gains in 1960; $8,300,000 in 1959.
[3] Fiscal year ends Nov. 30.
[4] Fiscal year ended June 30.
[5] Before non-recurring costs of $2,000,000 (mostly tanker cancellations) charged against 1960 net income, earnings would be down 7.5% for 4th quarter and up 9% for year.
[6] Before taxes.
[6] Includes nonrecurring profit of $3,409,000 from the sale of assets.



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The Layne Gravel Wall Well is an example of Layne experience, engineering and research. This gravel packing and 134 shutter screen employment affords larger screen openings, reduced friction, reduced draw down and pumping head. It increases specific capacity and makes for more effective retention of native sands. For additional information write for bulletin 900.

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"This Is What He Means"

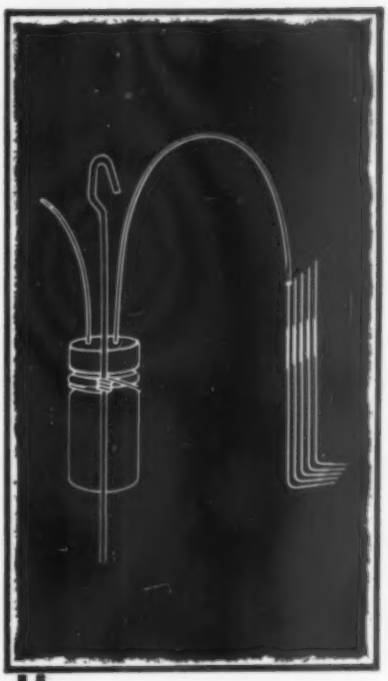
A pocket translator for checking executive references

Ordinarily, an executive asked for a job reference about a former subordinate will do his best to say what he means and mean what he says. And, as a rule, his remarks about the job candidate can be considered sound (though sometimes rather sanguine) evaluations. There are times, however, when the better judgment of an experienced reference-checker suggests to him that all that glitters may not be gold, and that glib and glowing references are no exception to this rule. The following are not presented as infallible clues; they're simply examples of the kinds of accolades that are sometimes delivered —and truths that may lurk behind them.

"He's a consistently good team worker."	*Hasn't had an original thought in twenty years.*
"He's always staunch in supporting his superiors' recommendations."	*A yes man.*
"A strong speaker who really *sells* his ideas."	*Big mouth.*
"Conscientious? I can't tell you how many times I've seen him take work home nights or on weekends."	*He can't get organized.*
"He's volunteered to serve on most of our management committees."	*Afraid to make his own decisions.*
"He's at his best when handling the broad outlines of a situation and delegating the details."	*He can't add.*
"A great believer in face-to-face communications, rather than memos and reports."	*He can't spell.*
"He had good command of the job, considering his age."	*Too young to cut the mustard.*
"I believe he's thinking in terms of $25,000."	*He'll jump at seventeen.*
"I'm sure you'll find him capable of handling *any* job you have in mind."	*We're glad to get rid of him.*

Courtesy of *Management Review*

CANNON PENS



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Management Personals

H. A. Jarvis

A. T. Proudfit

L. E. Lowry

▸ **Arthur T. Proudfit** has resigned as president of Creole Petroleum Corporation and will be succeeded by **Harry A. Jarvis. Leo E. Lowry** was elected executive vice president, the position formerly held by Jarvis.

Proudfit has been engaged in the oil business in Venezuela for almost 30 years, moving in 1927 from Mexico. He was with an affiliate of the Standard Oil Company (N.J.) of which Creole is also an affiliate. He became manager in Venezuela in 1942 and president of Creole in 1945, a position he occupied until November 4, 1954, when he was elected a member of the board of directors of Jersey Standard. He was named president of Creole the second time in February 1959, and has served in the post since that date.

Jarvis, with Creole for 14 years, came from Argentina where he had worked 16 years with another Jersey affiliated company. He was the first manager of the Amuay refinery, a post to which he was named in January 1947. Two years later he was named manager of the refinery department, and in 1950 he became a member of the company's management committee. He was elected to the board of directors in 1952 and became executive vice president in 1954.

Lowry has been with Creole for 22 years. He went to Venezuela in 1938 from the United States and has held a series of positions in the comptroller's department, including the post of comptroller. In 1953, he was elected to the board of directors of the company.

The board of directors of Creole has as its members — in addition to Proudfit, Jarvis and Lowry—**Dr. Guillermo Zuloaga, Dr. Carlos Lander M., Dr. Federico Baptista, H. J. Wright** and **R. E. Mays,** of Caracas, and **H. A. Metzger,** New York.

▸ Retirement of **Frank H. Bacon** as general attorney of Cities Service Petroleum Company and reorganization of the Bartlesville, Okla., legal division were announced. In connection with the reorganization, the closing of the Houston legal office of the company and the transfer of four attorneys from the legal division of Arkansas Fuel Oil Corp. at Shreveport were announced.

Following Bacon's retirement, **Cecil C. Cammack** will become assistant general counsel. **George Conger,** formerly principal attorney for Arkansas Fuel Oil Corp. and **R. O. Mason,** who has been a staff attorney in Bartlesville, will become general attorneys. **Roy Z. Johnson** is designated as chief title attorney.

David O. Dillon of Houston and **George Gilbert, Frank Jones** and **Robert LeBlanc** of Shreveport are the other attorneys being transferred to the Bartlesville office. The legal division will continue to maintain a division office at Midland, Texas, where three staff attorneys are located.

▸ **Joseph T. Wilson Jr.** was elected a director and secretary-treasurer of Sun Oil Company. Wilson succeeds **John C. Agnew,** who retired.

Wilson's former responsibilities as assistant secretary-treasurer will be assumed by **William S. Woods Jr.,** previously manager of the treasury department's financial and corporate stock division and an assistant secretary-treasurer. Woods is succeeded in both posts by **John P. Leech,** former assistant to the manager of the financial and corporate stock division.

In addition to their new responsibilities with the parent company, Wilson, Woods and Leech will assume additional executive posts with Sun's subsidiary companies.

Agnew retired after a 41-year career with the Sun organization. He rose through the financial ranks of the company to his present post and to executive positions with 17 Sun subsidiaries. He is a director and officer of six subsidiaries, a director of the company's eight foreign production subsidiaries, and an officer of three others.

▸ **Martin A. Row** was named special counsel for foreign operations in Sun Oil Company's production department. He succeeds **John W. Timmins,** retired. Row has been associated with the legal staff for almost 35 years and continues as counsel for regulatory and natural gas matters for that department.

▸ **Harold W. Haight** was named an executive vice president of Humble Oil & Refining Company. **Nelson Jones** moved to the Humble board of directors from his post as Humble's general counsel. **Forrest M. Darrough,** who has been associate general counsel, succeeds Jones.

Haight has been serving as a vice president and member of the board of directors.

W. L. Naylor

▸ **William L. Naylor** has retired as a senior vice president of Gulf Oil Corporation. He joined Gulf in its crude oil purchasing department in 1920. Naylor went to Mexico in 1923 in charge of financial affairs for the Mexican Gulf Oil Company, a subsidiary with headquarters in Tampico. It was there, until 1928, that Naylor directed financial activities amid several revolutions and persistent troubles with Mexican bandits. He then moved to Pittsburgh in 1928 as a member of the comptroller's staff. He advanced to assistant comptroller in 1934 and was elected comptroller in 1948. He was elected senior vice president in 1955, becoming a member of the management committee.

▸ **Byron K. Fickle,** assistant treasurer and manager of the credit division of The Ohio Oil Company, has retired after over 40 years with the company. He is succeeded by **G. A. Southard,** assistant manager. Southard is succeeded by **G. A. Chickedantz,** former general credit supervisor. **R. C. Rice,** supervisor of wholesale credit, becomes general credit supervisor.

▸ **Louis J. Brunel,** who has been an officer of Bishop Oil Company since 1927, retired as president of the company. The board of directors elected geologist **Donald I. Lawless,** vice president of Canadian Bishop Oil, Ltd., to succeed him. The board also increased its size from seven to eight to make Lawless a director. Brunel will continue as a director and serve the company in a counseling and advisory capacity.

Brunel served as vice president and general manager of Bishop for 32 of his 35 years with the company, becoming president in 1959. He has been a member of the board of directors since 1927, and president of Canadian Bishop since 1957.

▸ **John A. McCone** was elected a director of the Standard Oil Company of California announced Board Chairman **R. G. Follis.** McCone was chairman of the Atomic Energy Commission in the Eisenhower administration. He succeeds **Robert Watt Miller,** who resigned.

I. G. Davis

J. E. Bounds

B. R. Dorsey

▸ **I. G. Davis** and **J. E. Bounds** were elected new executive vice presidents of Gulf Oil. New senior vice president is **B. R. Dorsey.**

Davis, formerly a senior vice president, is a member of the company's executive and will have general corporate duties. Bounds, previously administrative vice president and coordinator — financial department, will be a new member of the executive, and will have general corporate duties. Dorsey, previously administrative vice president and coordinator — manufacturing department, will have as his primary responsibility the general areas of refining, petrochemicals, product supply and product transportation on a worldwide basis.

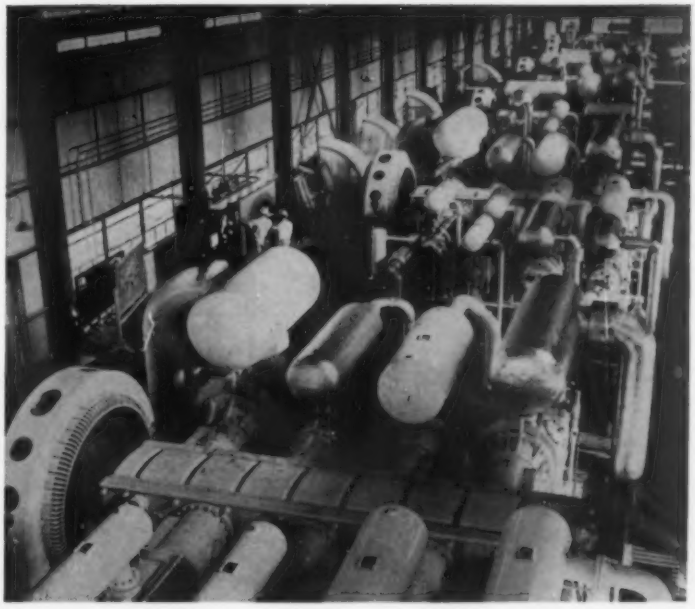
All three men will continue to be based in the company's executive and general headquarters in Pittsburgh.

▸ **Charles H. Wager,** general traffic manager for Shell Oil Company and Shell Chemical Company, was appointed chairman of the Central Committee on Railroad Transportation of the American Petroleum Institute. The committee includes top traffic executives of oil companies throughout the country, and is concerned with the movement by rail of petroleum products.

▸ **John A. Armstrong** was appointed to the board of directors of Imperial Oil Limited. Armstrong, who is general manager of the company's producing department, fills the vacancy on the board left by the retirement of **George L. Macpherson,** who has been a director since 1954.

Armstrong served as assistant manager of the company's western producing region, except for one year he spent in New York with Standard Oil Co. (N. J.) as assistant producing coordinator. He became general manager of the company's producing department last year.

Macpherson was general manager of the manufacturing department when he was elected a director of the company in 1954.



Petroleum Chemicals, Inc., Installs 98 Burgess-Manning Snubbers To Prevent Pulsation Damage In New Ammonia Plant

Foster Wheeler Corporation was contracted by Petroleum Chemicals, Inc., to design and construct a multi-million dollar ammonia process plant at Lake Charles.

Realizing that gas pulsation would cause severe operating problems in the multi-service process piping related to reciprocating compressors, and that hazardous pulsation should be engineered out of the plant in the initial design, Foster Wheeler called upon Burgess-Manning Company to develop pulsation snubbers for various service conditions and for installation under the original contract.

Ninety-eight pulsation snubbers of 46 individual designs were installed on multi-stage, multi-service compressors. The snubbers were installed on both the suction and discharge sides of the compressor cylinders in what is believed to be *the largest single installation of pulsation snubbers under one roof.*

The compressors handle various types of gases, ranging in molecular weight from 5.13 to 33, at pressures from atmospheric to 9,270 P.S.I.A.; and at discharge temperatures to 350° F. Under these exacting conditions, Burgess-Manning accepted the responsibility to engineer and supply pulsation snubbers of optimum design that would: *1. Hold the pulse amplitude to 2 per cent or less, total surge peak-to-peak, of absolute line pressure, and 2. hold a minimum pressure drop requirement.*

The snubbers were subjected to the stringent specifications of material, workmanship, and inspection procedures normally followed by Foster Wheeler in process plants of this type. All forged snubbers for high-pressure service were made of high tensile alloy steel. Internal assemblies were engineered to withstand extreme forces.

After the plant went on stream, operational inspection revealed minimum pulsation-induced vibration, eliminating operating hazards, constant maintenance, and upkeep of the laterals, headers, intercoolers, and separators attendant to the snubbers.

If you are planning a new plant, or have a pulsation problem in your present plant, it will pay you to consult Burgess-Manning — "The Sound Engineering People." There's no obligation, of course.

Industrial Silencer Division
BURGESS-MANNING COMPANY
The Sound-Engineering People 9241 SOVEREIGN ROW • DALLAS 7
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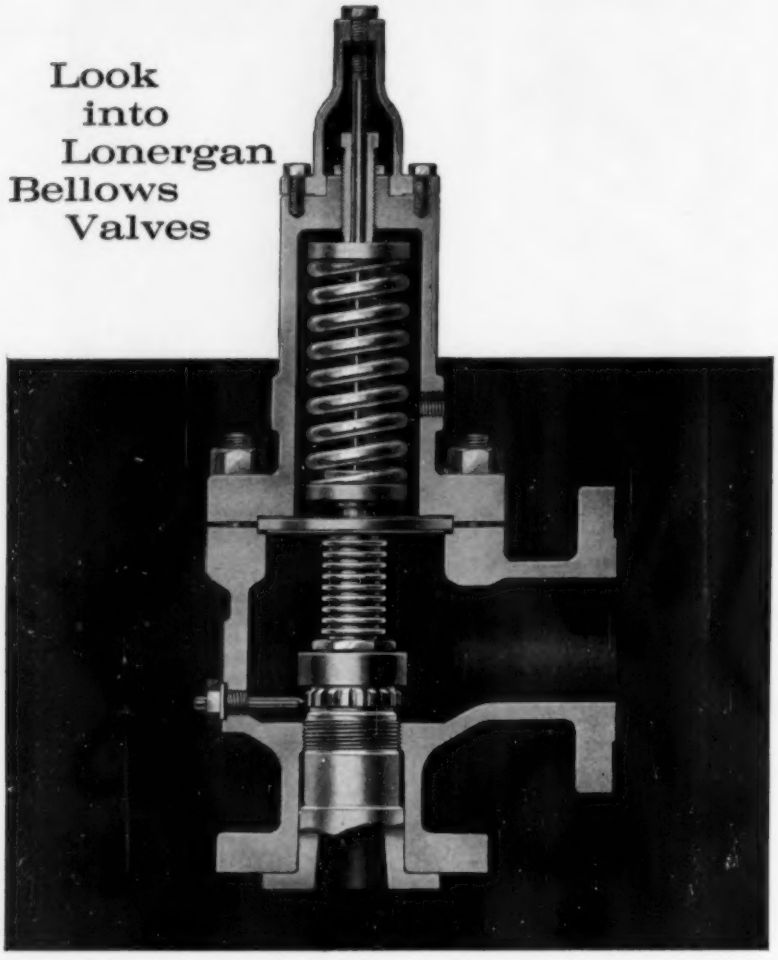
Look into Lonergan Bellows Valves



Seven exclusive features reduce maintenance costs; provide increased valve versatility.

Like all bellows valves, Lonergan valves are designed to keep corrosive or viscous fluids away from working parts. In addition, they provide a balancing action against a variable back pressure. The similarity between Lonergan and any other bellows valve ends there. *Only Lonergan valves provide:*

1. ***Saf-T-Alarm to warn of bellows failure. Alarm may be remotely located. (Optional at extra cost.)**
2. **Complete interchangeability with conventional valves of the same series.**
3. **Versatile cap arrangement. Bolted cap is standard and is interchangeable with a packed cap without taking the valve off the line or out of service. Gag facility is included.**
4. ***Simplified nozzle replacement due to an exclusive knockout feature. (Optional.)**
5. **A Hydro model; a patented, true, non-chattering liquid valve. Elimination of chatter ends bellows failure due to excessive flexing.**
6. **Reserve seating surface obtained from a built-in spare disc.**
7. **PVC trim, where pressure-temperature conditions permit.**

These seven features mean economy for Lonergan valve users—in first cost; in operation; in maintenance. If your plant uses bellows valves, then it will pay you to investigate Lonergan. Series DB bellows valves are described in a new bulletin. Series D valves, available without the bellows, are also described. Write for your copy today.

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F. H. Moore

H. L. Waszkowski

Fred H. Moore was appointed executive vice president of Mobil Oil Company, Socony Mobil's operating division for the United States and Canada, it was announced by **Herbert Willetts,** president of Mobil Oil.

In this newly established position, Moore will coordinate the activities of the marketing, manufacturing, supply and distribution, pipe line and traffic departments. Since joining a Mobil affiliate in the Southwest 25 years ago, Moore has given executive direction to a variety of company operations both in this country and in Canada. Since March 1, 1959, he has headed Mobil Oil's exploration and producing activities as a vice president.

H. L. Waszkowski Jr. of Houston, Texas, was made vice president of the exploration and producing department. As a division vice president, he has been managing Mobil Oil's exploration and producing programs in the South Texas-Gulf Coast area. He will now move to New York, reporting directly to Willetts.

R. R. Jackson, now vice president of manufacturing and supply, was named vice president of programs and supply-distribution, a new post. He will coordinate programming of profit opportunities for Mobil Oil as they affect availability and distribution of products.

Waszkowski announced three new appointments in Mobil Oil's exploration and producing department: **E. V. Watts,** division vice president at Denver, becomes division vice president at Houston. **A. O. Detmar** of Calgary, Alberta, now president of Mobil Oil of Canada, Ltd., succeeds Watts at Denver as division vice president. The new president of Mobil Oil of Canada is **O. H. Blexrud,** currently exploration manager in the Midland, Texas, division. His offices will be in Calgary.

Edward E. Lynn, vice president, Fairbanks, Morse & Co., was named assistant general counsel of The Youngstown Sheet and Tube Company. In August 1947, he joined Fairbanks, Morse & Company as vice president, later becoming chief legal officer, where he remained until joining Youngstown.

Carrol M. Bennett was named to the newly-created post of president of Frankfort Oil Company. Bennett, vet-

eran of more than 25 years in the oil business, has been director of oil operations since 1956. He will continue also as head of Carrol Bennett & Associates, financial-management consulting firm.

▸ **E. R. Jones** was appointed vice president of manufacturing, and **C. J. Carle** named industrial relations manager for the manufacturing and pipeline departments of Derby Refining Co.

Jones started as assistant refinery superintendent in 1939, refinery superintendent in 1948 and in 1958 refinery manager. Carle began on the transport loading rack and then worked into the refinery office in 1944. In 1953 he became transport loading foreman and in 1959 became refinery personnel manager.

▸ **James Kelly** was appointed district manager of the Philadelphia office of Marsh Instrument Company, serving eastern Pennsylvania, New Jersey, District of Columbia, Maryland and Delaware. Before taking charge of the Philadelphia territory, he was Midwestern district manager. Replacing him is **Robert Ely** as Midwestern district manager serving Illinois, Indiana, Western Michigan, Iowa, Nebraska, Missouri, Kansas, Colorado, Wyoming and Montana. Ely has been a district sales representative in the midwestern territory.

▸ **Arnold F. Kaulakis** was elected a vice president and member of the board of directors and executive committee of Esso Research and Engineering Company. Kaulakis will have responsibility for the engineering operations of the firm which is the principal scientific affiliate of Standard Oil Company (New Jersey). He has been serving since last March as acting general manager of engineering. The new vice president is a former director of the process research division and of the company's employee relations unit.

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SEALED BIDS will be received by the undersigned until 2:00 o'clock P.M., Friday, March 31, 1961, for purchase by cash of 100% of the working interest of five (5) Tyler sands wells (presently producing approximately 220 BOPD) and miscellaneous personal property constituting and located upon the following:

All Section 16, T-11N, R-31E, Musselshell and Rosebud Counties, Montana, containing 640 acres, more or less.

Additional information may be requested from or inspected at 803 Midland Bank Building, Billings, Montana.

The right to reject any or all bids is reserved.

Final decision with reference to the disposition of the bids will be made within (15) days of the opening.

Upon acceptance of any bid the applicant must tender a certified check in the amount of $10.000.00 within five (5) days of notification of acceptance. Balance upon title clearance.

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Books To Read . . .

▸ **"Paleogeologic Maps,"** *by A. I. Levorsen. Published by W. H. Freeman & Company, 660 Market Street, San Francisco 4, California. 174 pages. Price $6.*

In a simple, straightforward manner, this small volume demonstrates how paleogeologic maps may be used by students and practicing geologists interested in the history of sedimentary rock sequences. How maps are prepared — how some interpretations may be made from them, etc., are some of the helpful tips provided.

▸ **"Historical Statistics of Minerals in the United States"** *compiled and annotated by Sam H. Schurr. Published by Resources for the Future, Inc., 1775 Massachusetts Ave., N. W., Washington 6, D. C. 42 pages. $1 per copy.*

Good reference material on the petroleum, natural gas and gas liquids is found in this bulletin, which is a reprint of the minerals chapter of "Historical Statistics of the United States — Colonial Times to 1957," published in 1960. Tables and notes have been reviewed by specialists, among them, Robert E. Herman of the U. S. Bureau of Mines. The Census Bureau staff charged with the publication of "Historical Statistics" did the final editing. Resources for the Future is financed by the Ford Foundation.

▸ **"The Physics of Flow Through Porous Media,"** *by A. E. Scheidegger. Published by the MacMillan Company, 60 Fifth Avenue, New York 11, New York. 313 Pages. Price $15.50.*

The material contained in this volume has been scattered throughout a multitude of journals and text books (see The Petroleum Engineer, Drilling and Producing Edition, December 1960, B-110), and this is the first time a compact volume summarizing information on the physical principles of hydro mechanics in porous media has been published. Dr. Scheidegger has made a thorough search of existent literature on the subject, including sources behind the Iron Curtain.

A number of topics are presented for the first time: A complete discussion of past and present physical theories of flow through media, including a theoretical deduction of Darcy's law, a critical evaluation of the Kozeny theory, and a presentation of statistical flow theories. The book expounds the theory of the advance of the saturation front in the displacement of a fluid in a porous medium by another which is miscible in the first.

▸ **"Proceedings of Seventh Annual (1960) West Texas Oil Lifting Short Course,"** *prepared by Texas Technological College, Lubbock, Texas. Contains 43 papers. Price, $7.50.*

Experts discuss various problems of lease operation and oil lifting, publication contains a wealth of information designed to be of value to operators, owners, and educators.

▸ **Electric Analogue for Resistivity Logging,** *by Hubert Guyod, consultant, P.O. Box 282, Bellaire, Texas. 117 pages of text, 120 diagrams, charts, and other types of illustrations. Price $50.*

Book was prepared originally for six major oil companies as a report summarizing and analyzing some of the calculations done with author's analog computer. Companies now have released it for sale to the public. Report is in two parts, and the first part describes at length the analog and its operation. Second part is a thorough investigation of the response of normal and lateral resistivity curves on single and multiple beds.

▸ **"Statistics Manual,"** *by Edwin L. Crow, Frances A. Davis and Margaret W. Maxfield. Published by Dover Publications, Inc., 180 Varick Street, New York 14, New York. 288 pages. Price, $1.55.*

This manual of statistical procedures is intended for use by scientists and engineers. In the planning stages of tests and experiments, however, it is advisable to supplement the information by occasional consultations with statisticians.

The preparation of the manual was first undertaken at the Naval Ordnance Test Station in 1948 to provide for the basic statistical study of the programs of the Station. Work on the manuscript was not completed at the termination of this task assignment, and the continuation of its preparation from 1950 to 1955 was supported by funds from exploratory and foundational research and general overhead.

▸ **"Can Capitalism Compete?"** *by Raymond W. Miller. Published by The Ronald Press Company, 15 East 26th Street, New York 10, New York. 264 pages. Price, $4.50.*

With a sub-title "A Campaign for American Free Enterprise" you have a good idea of what this book is about. Written by a globe-trotting economist and international public relations man, the author blueprints in readable fashion a campaign for selling the world's millions on what he terms dynamic capitalism of service. In his travels around the world, he said that with all our supersalesmanship we have not been able to sell capitalism itself; that with all our exports we have been unable to export our system of free enterprise. In fact, he contends that capitalism is a bad word in many lands.

The author urges all Americans — businessmen, government officials, and citizens in general — to play their part in spreading the news of how modern capitalism functions. His approach is always realistic and practical. The book is filled with thought-provoking examples of American enterprise in action abroad, and every chapter suggests concrete steps that can be taken immediately by large and small business, service clubs and other voluntary organizations, and every individual who travels abroad or has contact with overseas visitors.

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Laugh with Barney

H. G. Wells once defined a highbrow as "a man who thinks he has found something more interesting than women."

Elderly Lady: "Isn't it wonderful how these petroleum engineers know where to set up their gas pumps to get gas?"

"Mommy," said the little boy, "I was in a fight today."
"What happened, son?"
"Some boy called me a sissy."
"What did you do, Son?"
"I hit him with my purse."

The plumber was instructing his new assistant on the niceties of the trade. "Above all," he said, "you must exercise politeness and tact."

The assistant allowed as how he understood about politeness, but "what was tact?"

"Well, son," he replied. "It's this way. If you walk into a bathroom to fix a pipe and a young lady is in the tub you close the door quickly and say, "Beg your pardon, sir.' The 'Beg your pardon' is politeness. The 'sir' — that's tact."

"Did she blush when her shoulder strap broke?"
"I didn't notice."

A social worker was making the rounds of the hill country. She was an energetic old maid, but wasn't having much luck talking to a comely young lass.

"Yes'm," said the young mountain lady, "I guess birth control is all right for you. But me, I don't need it—I'm married."

"What party do you affiliate with?" the election judge asked the mountain girl.
"Has I gotta answer that?" she frowned.
"If you want a ballot you do."
"Wa-al, then I don't want to ballot 'cause the party I affiliates with ain't divorced yet."

Girl: What makes me so popular with the boys. Is it my looks?
Boy: No.
Girl: Is it my personality?
Boy: No.
Girl: I give up.
Boy: That's it.

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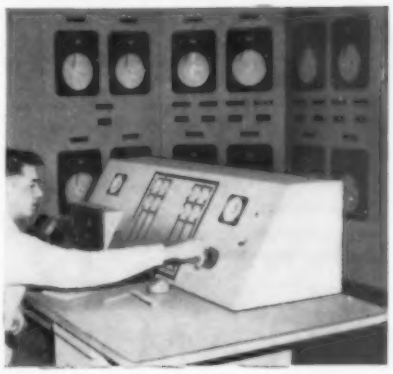

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Meetings . . .

Mar. 8-10 — **API Division of Production**, Southern District meeting, Captain Shreve and Washington-Youree Hotels, Shreveport, La.

Mar. 13-17 — **National Assn. of Corrosion Engineers**, annual meeting and corrosion show, Hotel Statler, Buffalo, N. Y.

Mar. 15-17 — **Natural Gasoline Assn. of America**, 40th annual convention, Baker Hotel, Dallas, Texas.

Mar. 20-24 — **12th Western Metal Congress and Exposition**, Pan-Pacific Auditorium, Los Angeles, Calif.

Mar. 22-24 — **API Division of Production**, Southwestern District meeting, Cole Hotel, Albuquerque N. M.

Mar. 23 — **National Industrial Conference Board**, general session, Shamrock-Hilton Hotel, Houston, Texas.

Mar. 27-29 — **Midwest Gas Assn.**, annual meeting and convention, Sheraton-Fontenelle Hotel, Omaha, Neb.

Mar. 27-31 — **ISA**, 3rd Symposium on Temperature, Veterans Memorial Auditorium, Columbus, Ohio.

Mar. 28-29 — **Southern California Meter Association** instrument short course, 10th annual, 1111 Figueroa St., Wilmington, Calif.

Apr. 3-7 — **Gulf Coast School of Drilling Practices**, University of Southwestern Louisiana, Lafayette, La.

Apr. 4-5 — **Gas Compressor Institute**, Liberal, Kan.

Apr. 5-7 — **API Division of Production**, Mid-Continent District meeting, Mayo Hotel, Tulsa, Okla.

Apr. 5-7 — **Kansas Oil Men's Assn.**, Management Institute, University of Kansas, Lawrence, Kan.

Apr. 7-9 — **Southwestern Alaskan Chapter AIME**, Sixth Annual Mining, Minerals & Petroleum Conference, Anchorage, Alaska.

Apr. 8-12 — **Petroleum Equipment Suppliers Association**, 26th annual, Greenbrier Hotel, White Sulphur Springs, W. Va.

Apr. 9-11 — **14th Annual Midwestern meeting**, Society of Exploration Geophysicists, Oklahoma City.

Apr. 10-13 — **American Society of Mechanical Engineers**, 33rd annual conference and exhibit of the Oil and Gas Power Division, Jung Hotel, New Orleans, La.

Apr. 10-14 — **Gulf Coast School of Drilling Practices**, University of Southwestern Louisiana, Lafayette, La.

Apr. 11-13 — **PIEA-PESA**, conference and exhibit, Galveston, Tex.

Apr. 17-19 — **ISA**, 7th National Symposium, Shamrock-Hilton Hotel, Houston, Texas.

Apr. 18-20 — **Southwestern Gas Measurement Short Course**, University of Oklahoma, Norman, Okla.

Apr. 24-27 — **AAPG-SEPM**, 46th annual, Denver Hilton Hotel, Denver, Colo.

Apr. 26-28 — **API Pipe Line Conference**, St. Louis, Mo.

Apr. 28 — **Natural Gasoline Association of America**. Oklahoma Regional Meeting, Lake Murray Lodge, Ardmore, Okla.

May 1-4 — **ISA**, 7th nat'l aero-space instrumentation symposium, Fort Worth, Tex.

May 1-5 — **Gulf Coast School of Drilling Practices**, University of Southwestern Louisiana, Lafayette, La.

May 3-5 — **API Division of Production**, Rocky Mountain District, Gladstone, Henning, and Townsend Hotels, Casper, Wyo.

May 8-12 — **Gulf Coast School of Drilling Practices**, University of Southwestern Louisiana, Lafayette, La.

May 10-12 — **CIM-AIME**, oil and gas division, 12th annual, MacDonald Hotel, Edmonton, Alberta, Can.

May 11-12 — **API Division of Production**, Pacific Coast District, Biltmore Hotel, Los Angeles, Calif.

May 12 — **Natural Gasoline Association of America**, Permian Basin Regional Meeting, The Lincoln Hotel, Odessa, Texas.

May 19 — **NGAA**, Permian Basin regional meet, Lincoln Hotel, Odessa, Tex.

May 22-24 — **ISA, AIEE, ARS, IAS, IRE**, 10th national telemetering conference, Chicago, Ill.

June 5-8 — **ISA** summer instrument-automation conference and exhibit, Royal York Hotel and Queen Elizabeth Hall, Toronto, Ontario, Can.

June 6-8 — **Appalachian Corrosion Short Course**, West Virginia University, School of Mines, Morgantown, West Virginia.

June 9-17 — **ACHEMA**, 13th international chemical engineering exposition and congress, Frankfurt am Main, Germany.

June 11-16 — **API Division of Production**, mid-year committee conference, St. Francis Hotel, San Francisco, California.

June 13-16 — **ISA**, 3rd biennial international gas chromatography symposium, Kellogg Center, MSU, East Lansing, Mich.

July 26-28 — **API**, Eastern District, Division of Production, Greenbrier Hotel, White Sulphur Springs, West Virginia.

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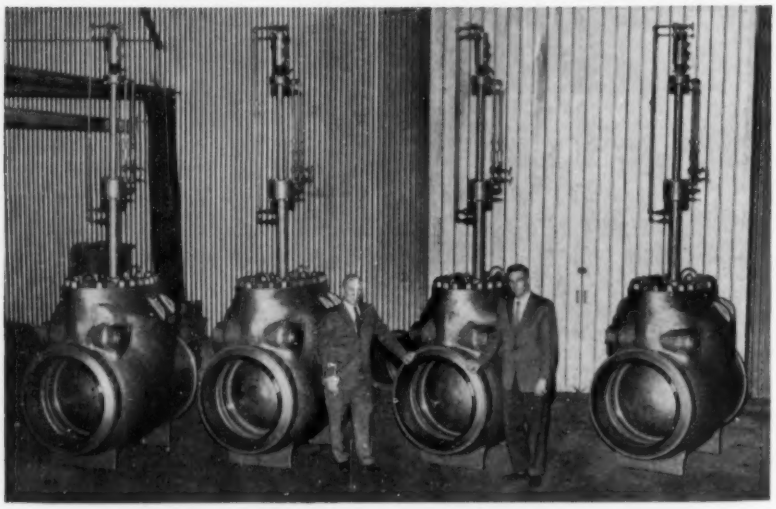
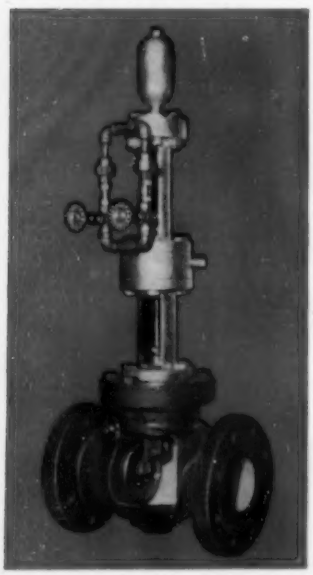
SLAM ELIMINATED!



Every major high pressure gas line under construction today will utilize Frank Wheatley's new Slam-Minimizer Check Valve. Above: a partial order of 30" Slam-Minimizer Check Valves ready for shipment to the Transwestern Pipeline project.



High pressure gas line maintenance and replacement savings in thousands of dollars are now possible through the use of Frank Wheatley's new Slam-Minimizer Check Valve. When installed and adjusted the Slam-Minimizer completely eliminates clapper slam and flutter. A unique hydraulic system governs the upward and downward movement of a piston linked to the clapper. The result — a smooth, quiet opening and closing under the most drastic mainline pressure changes.

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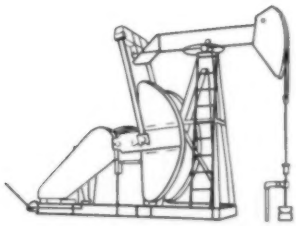

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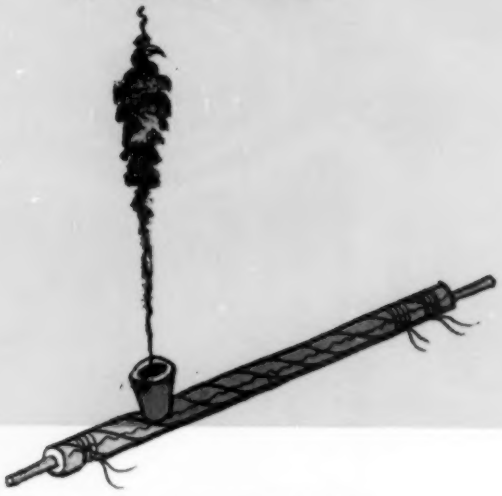

Development of tubingless completions—where tubing becomes casing or standard pipe—made necessary many new completion techniques.

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Of Things To Come . . . In Oil

WELL-SPACING BATTLES WILL GET HOTTER as several major producers push wider spacing requests to trim production costs. Several oil states have established or expanded spacing regulations in efforts to conserve reserves and to attract oil development interests. Small-tract drilling in Texas is under fire as at least two majors press their cases against the practice to the State Supreme Court. One small-plot well stands to produce $1 million worth of gas from land covering only $15,000 worth of reserves.

TEXAS GAS AND OIL WILL FACE TAX BOOSTS in present session of the State Legislature. Three tax proposals which were introduced unsuccessfully two years ago have reappeared: one would place graduated production tax on gas produced under "dedication" contracts, with cheapest gas paying highest tax; another would tax crude in proportion to volume produced by each producer; third is proposed 15¢-per-bbl storage tax on foreign crude imported into Texas. Other tax programs are expected as Texas seeks new revenue to offset state treasury decline.

SEARCH FOR BACTERIA-OIL CORRELATION WILL CONTINUE as Dr. A. W. Roach, North Texas State College biologist, undertakes program sponsored by grant from National Institute of Allergy and Infectious Diseases. Dr. Roach and assistants will take core samples up and down the Texas coast to determine "community environment" variations of micro-organisms, looking for "indicator organisms of conditions leading to the formation of oil deposits."

SOUTH LOUISIANA ACTIVITY WILL OUTSTRIP LAST YEAR in the area of new fields discovered. Four new fields in one week indicate good chances of passing last year's total of 42 new fields. Recent discoveries are located in Acadia and St. Martin Parishes and two in St. Landry Parish.

IDAHO WILL PAY BONUS FOR FIRST PRODUCER in the state if the state's legislature passes a bill recently introduced. Bonus would amount to $50,000 to be paid to owner of the first commercial well in Idaho to produce at least 50 bbl of oil per day for at least 60 days.

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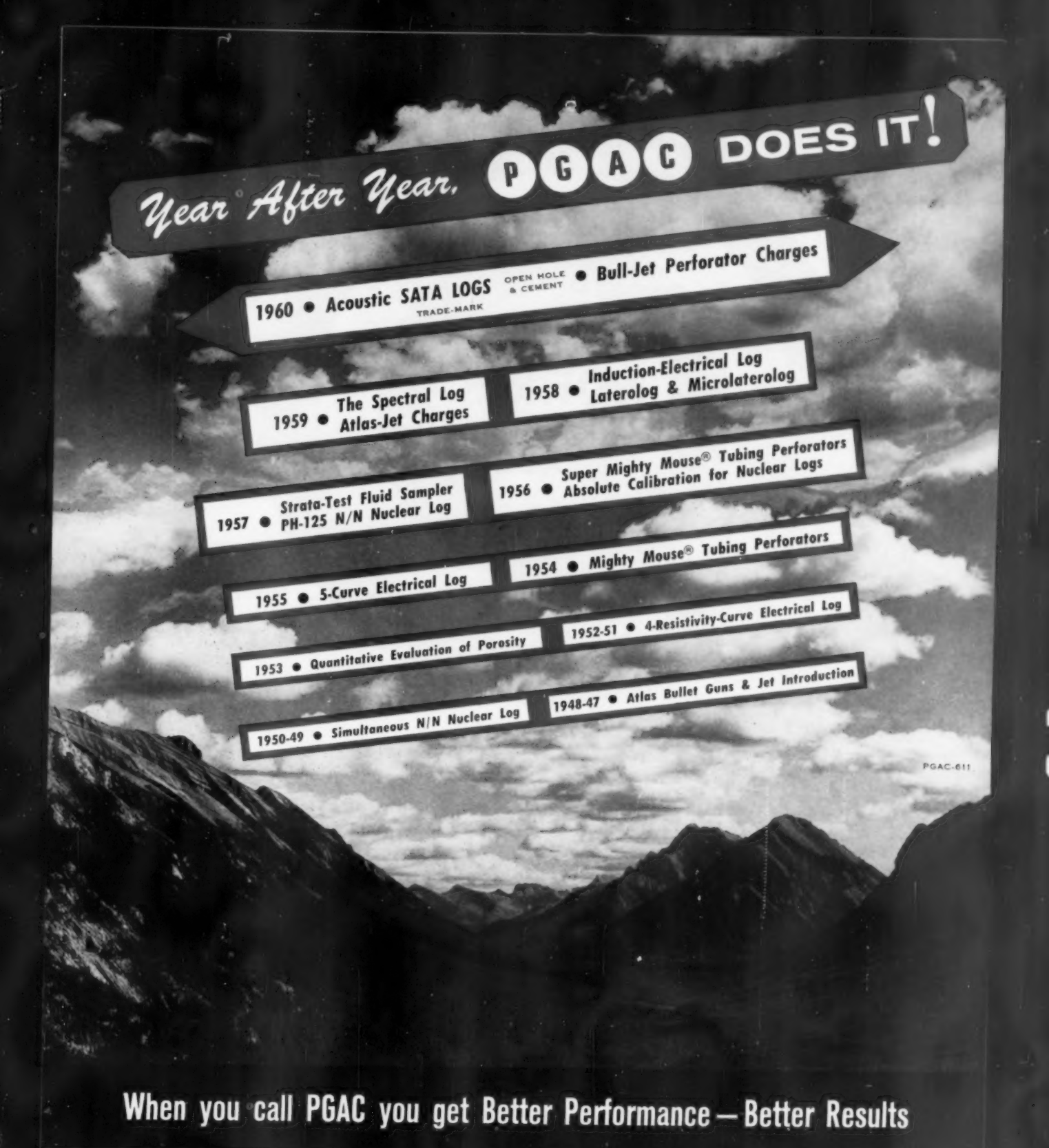
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Feet Drilled	3968	3790
Drilling Days	24	31
Feet per Day	165	122
Drill Pipe	4″	4½″
Drill Collars	15	15
Pumps	1 - 6½ x 16	1 - 6 x 20
Bits	31	40
Feet per Bit	125	95
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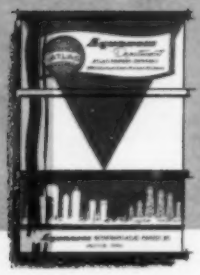

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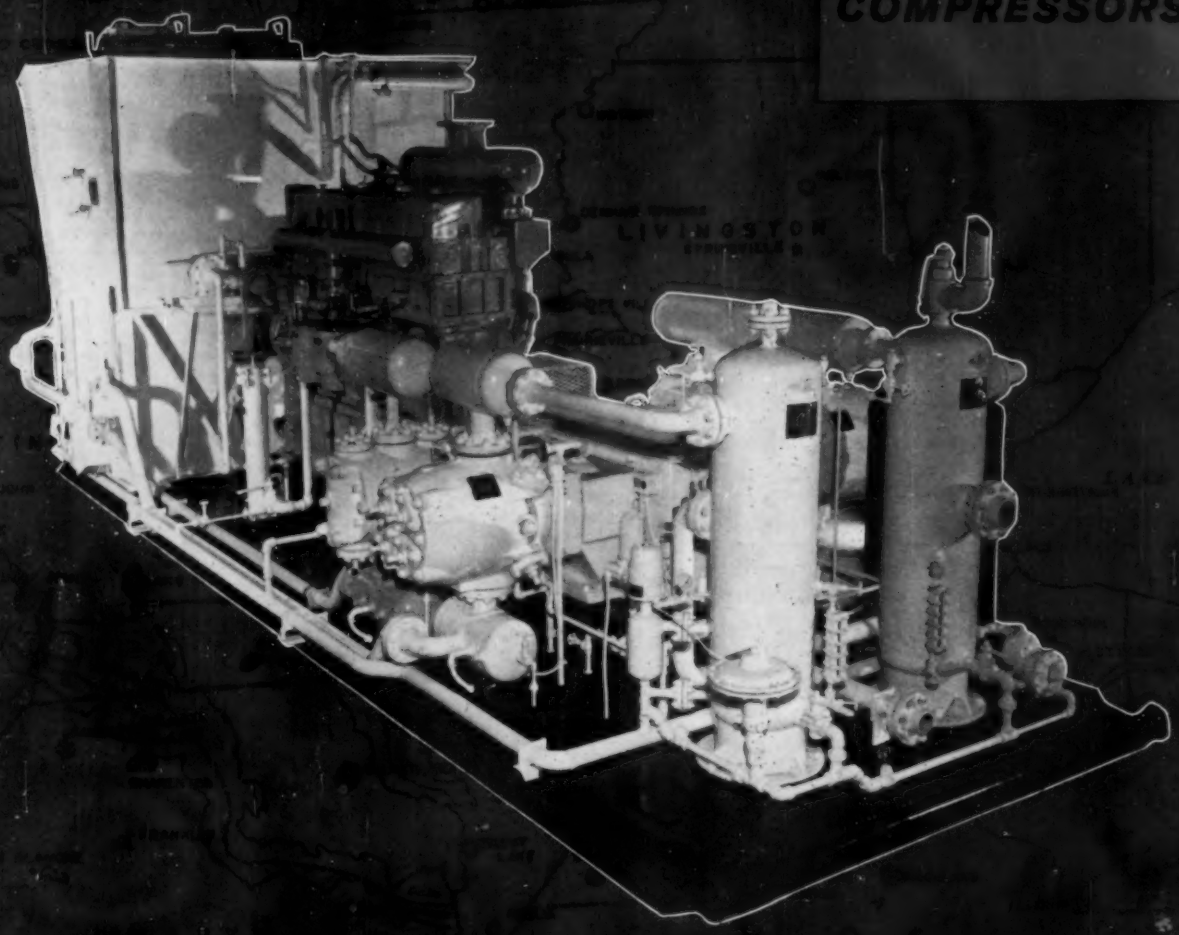

Three-Stage, 400 HP Compressor with 465 HP Prime Mover

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HIGH WELL FLOW INDEX

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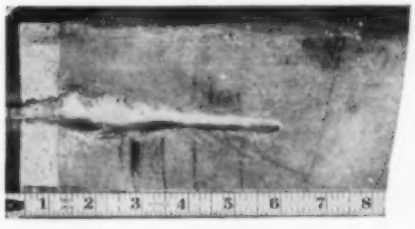
- Superior Perforation Characteristics – "big gun" performance – penetration equal to or better than that of many larger jet casing guns. Carrot-free perforations, large deep holes, high well flow index.
- Size, Shot Density, Length – 1 11/16" OD and 2 1/16" OD Standard shot density is four per foot, 90° phasing.

Disintegrating spacers are supplied to provide fewer shots per foot when required. Any number of Mac-Jet units may be run in any length desired.

SPECIFICATIONS:

	1 11/16" OD	2 1/16" OD
Pressure, Temperature Rating	15,000 psi. @ 300°	13,500 psi. @ 300°
Maximum Temperature	350°	350°
Total Charge Weight	12 grams	20 grams
Av. Penetration (Berea Sandstone)	5.69"	7.45"
Av. Entrance Hole	13/32"	7/16"
Av. Well Flow Index	1.1+	1.44
Fill-up – 1' Gun, 5 1/2" Casing	1"	–
Fill-up – 1' Gun, 7" Casing	1/2"	1"



Standard Berea Sandstone target perforated by 1 11/16" OD Mac-Jet. Average penetration, 5.69"; average entrance hole size, 13/32; average well flow index, 1.1+

DISINTEGRATING SPACER – Available in various lengths to provide fewer than four shots per foot. Disintegrates into small bits when perforator is fired.

McCullough *TOOL COMPANY*

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Trinity
LITE-WATE

A Complete Low Density Cement that is

HIGHLY IMPERMEABLE

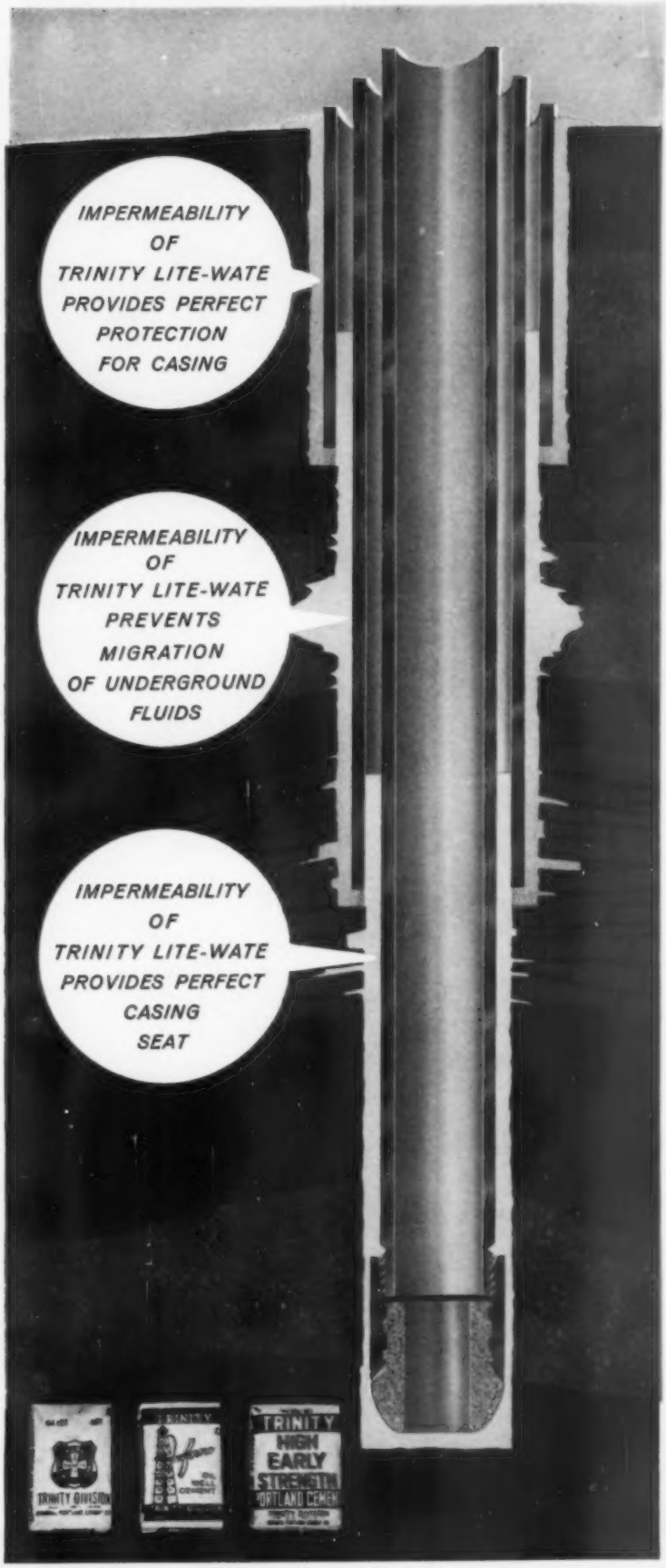
Trinity Lite-Wate fulfills all important functions when placed in an oil or gas well.

PERMEABILITY TEST DATA

All slurries were prepared according to procedures of API RP IOB and cured at 140°F and atmospheric pressure for 72 hours.

Percent Mixing Water	Slurry Wt. Pounds Per Gallon	Permeability Millidarcys*
65	13.66	0.001
75	13.18	0.001
85	12.77	0.001
95	12.44	0.001
105	12.14	0.002
115	11.89	0.003

*A darcy is that measurement of permeability that will permit a liquid having a viscosity of one centipoise to flow at the rate of one milliliter per second through a specimen one centimeter in length and having a cross section of one square centimeter under a pressure difference of one atmosphere. A millidarcy is 0.001 darcy. The permeability of Trinity Lite-Wate cement is expressed in millidarcys.


IMPERMEABILITY OF TRINITY LITE-WATE PROVIDES PERFECT PROTECTION FOR CASING
IMPERMEABILITY OF TRINITY LITE-WATE PREVENTS MIGRATION OF UNDERGROUND FLUIDS
IMPERMEABILITY OF TRINITY LITE-WATE PROVIDES PERFECT CASING SEAT
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TRINITY HIGH EARLY STRENGTH PORTLAND CEMENT

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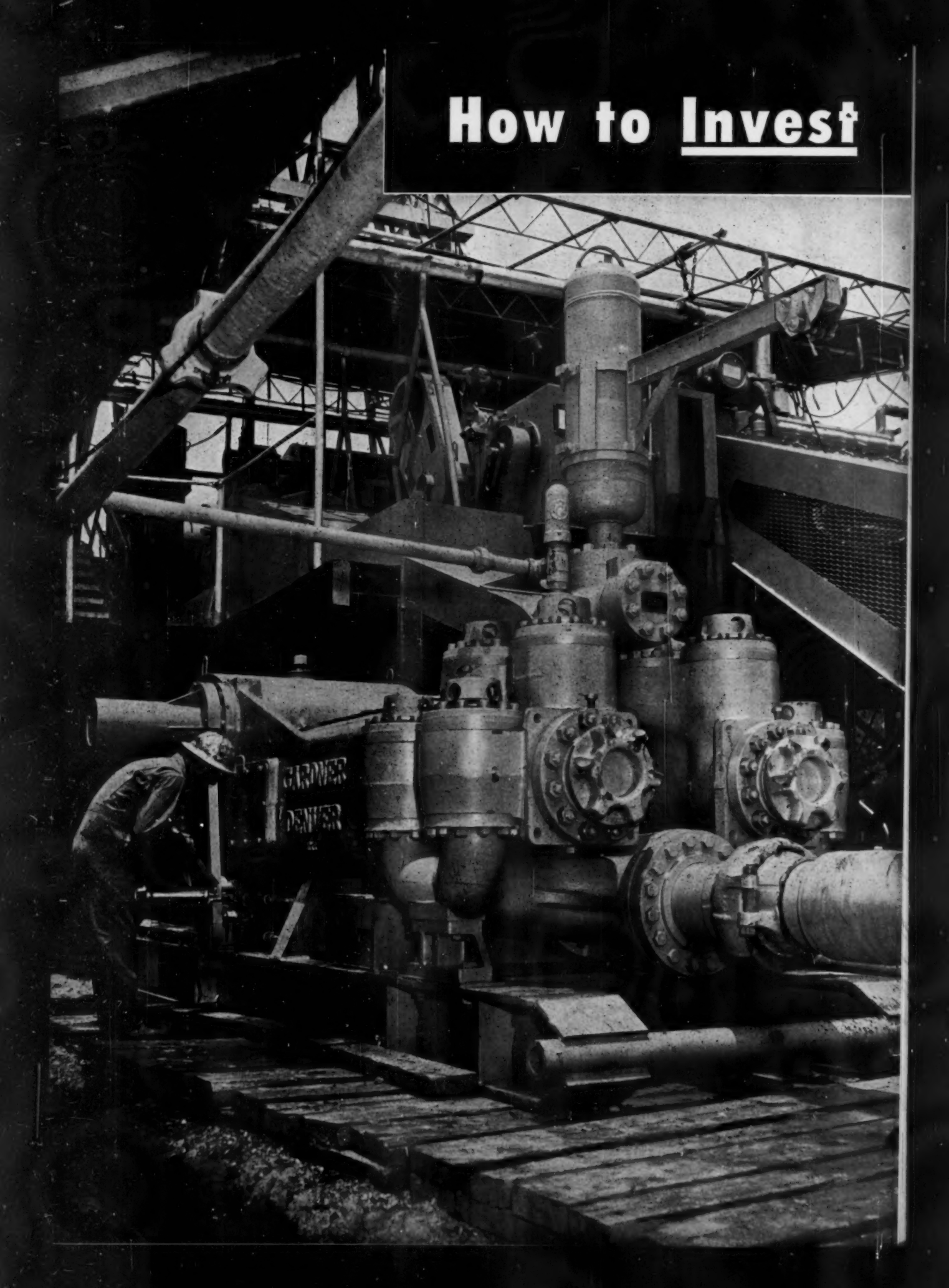
How to Invest



in Drilling Equipment

Drilling equipment well designed for your purpose, made to last, and serviced by a responsible supply company should rule out all other considerations. That's the difference between *buying* and *investing*.

You *know* from experience or observation that good design and long life are inherent in drilling equipment sold by J&L Supply. You *know* that J&L Supply has the organization, the parts inventories, and the determination to service what it sells.

Equipment universally respected by the drilling industry includes *Gardner-Denver Mud Pumps, Republic Hose, Ideco Rigs and Masts, J&L Wire Rope, and J&L Drill Pipe.*

J&L Supply sells the quality equipment you need and offers service facilities and policies designed to save you time and money at every step.

Remember, only quality equipment can give you the performance life that leads to real economy. Invest in quality and save at J&L.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

If it's sold by J&L....
It's the best available

100

Above — J&L Drill Pipe is made in sizes and grades for drilling to any depth. Ask your J&L Supply man for technical details.

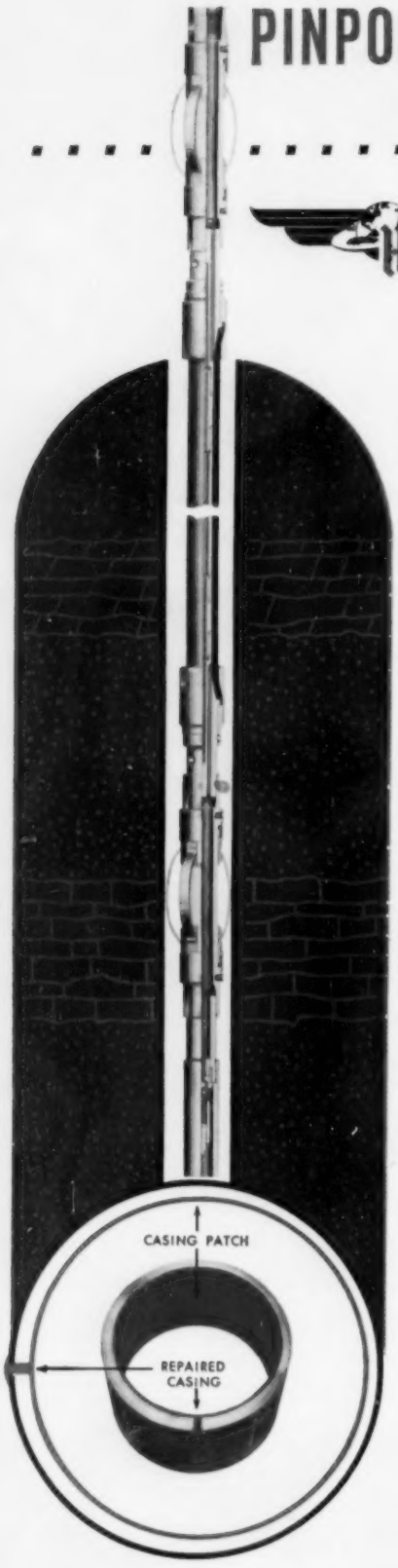
Above — Ideco Full-View Mast. Ask for literature on Ideco Drawworks, Rotaries, Blocks, Masts and Rambler Rigs.

Below — There is real assurance in the rugged strength of J&L Wire Rope.

Gardner-Denver Mud Pump at work in Mississippi. Ask your J&L Supply man for illustrated literature. Parts stocked at near-by J&L Supply stores protect your Gardner-Denver investment wherever you drill.

PINPOINT AND REPAIR CASING LEAKS

. . . . . *in the hole* . . . .



This new, advanced version of the field-proven Halliburton Casing Patch Applicator now enables you to obtain an actual, accurate impression of the casing I.D. where a break is suspected *before* applying the Casing Patch.

A special impression material is placed around the inflatable mandrel of this unique tool before running it in the hole. When the suspected point in the casing string is reached, the mandrel is inflated, forcing the impression material against the casing I.D. The impression thus obtained serves as an accurate guide in pinpointing the size, shape and location of the casing leak.

With the knowledge provided by the impression, the tool may be re-run with the regular casing patch material on the mandrel. When the mandrel is inflated again, the specially compounded glass fabric and plastic laminate patch is applied to the leak. Excess plastic is forced out at the leak, forming a seal both inside and outside the casing.

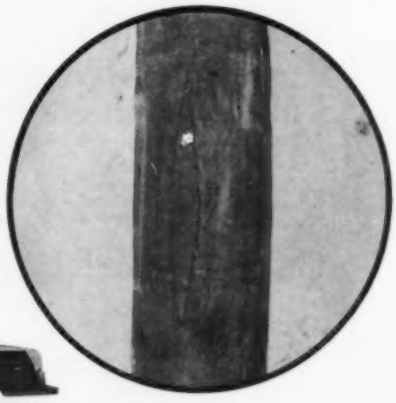
Already used successfully below 5,000 ft. The Casing Patch reduces the casing I.D. by only about ¼". After testing to determine stabilization of the patched area, the well is ready to resume work.

Investigate this most advanced technique of pinpointing and repairing casing leaks. Contact your nearby Halliburton Representative.

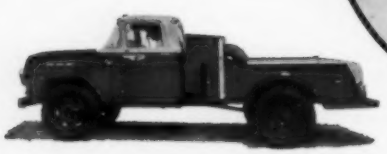
HALLIBURTON

SPECIAL TOOLS SERVICES

HALLIBURTON COMPANY • DUNCAN, OKLAHOMA



Impression of casing leak



SPECIAL TOOLS FOR SPECIAL PROBLEMS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Roll out the BOWEN CASING ROLLER

Roll out the Casing

Roll up the Savings

Heavy costs can be incurred when production or drilling equipment is forced through, or into, a section of collapsed or dented casing. Not only could the tools be damaged severely, requiring expensive replacement, but the casing could be permanently damaged. Correcting this situation would create even more cost!
The expense created by dented or collapsed casing can be eliminated by STRAIGHTENING OUT THE PROBLEM WITH A BOWEN CASING ROLLER.

THE BOWEN CASING ROLLER is used specifically to recondition and restore buckled, collapsed or dented casing to its normal internal diameter and roundness. This is accomplished by rotating and forcing the Casing Roller downward into the damaged area. As the tool is rotated into the reduced diameter, it exerts lateral forces on the casing to restore it to its original and normal I.D.

THE BOWEN CASING ROLLER contains no small or intricate parts to be worn, broken or lost in the well. It is manufactured from special alloy steels to resist wear. The Mandrel and all Rollers are case-hardened to provide even better wear qualities.

Demand the best — *Bowen* Casing Rollers. Complete information available upon request.

For over 25 years—the world's leading manufacturer of fishing and specialty tools.

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BOWEN

BROWN HS-16-1 PACKERS FOR DOWN-HOLE PROFITS

HS stands for "Hydraulically Set" in the type designation of this advanced design, multi-purpose packer because it is simply set by hydraulic pressure.

HS also stands for "Highly Salvable" because this packer is readily retrievable and may be rerun immediately after servicing.

HS also stands for "Hydrogen Sulfide" because this packer – without springs on wiper blocks to become embrittled, with lead seals to protect the synthetic rubber seals, and with H_2S resistant materials throughout – is ideal for areas where H_2S is encountered. But, however you name it, no other packer has the versatility or offers the profit making advantages of the Brown HS-16-1. Just check these money saving features:

MULTI-PURPOSE • A packer for single zone completions • A packer for single-string dual completions • As the lower packer in multiple-string completions • As the packers (any number in the same well) for multiple alternate-zone installations. • An excellent packer where acidizing or fracturing is being done. Dual slips enable the packer to withstand high differential pressures – pressure exceeding tubing limit.

RUNNING • **Circulation with the well head in place,** and before setting the packer eliminates wire line work. • Savings in rig time while running and setting. Ample by-pass area allows free flow of well fluid around the packer. • The HS-16-1 is easily run in straight or deviated holes. • No difficulty in running the packer into the top of a liner.

SETTING • **Positive well control is achieved since the well head is installed before the packer is set** or drilling fluid displaced. • **Producing zones may be washed after the well head is installed.** • No tubing manipulation necessary to set packer. • Design eliminates the possibility of premature setting. • The "hydraulically-set" feature minimizes the problem of spacing out. • Set at any depth as no tubing weight is required when setting. Hydraulic setting allows the tubing to remain in tension due to its own weight. • Treating fluid may be spotted across the producing zone before the packer is set.

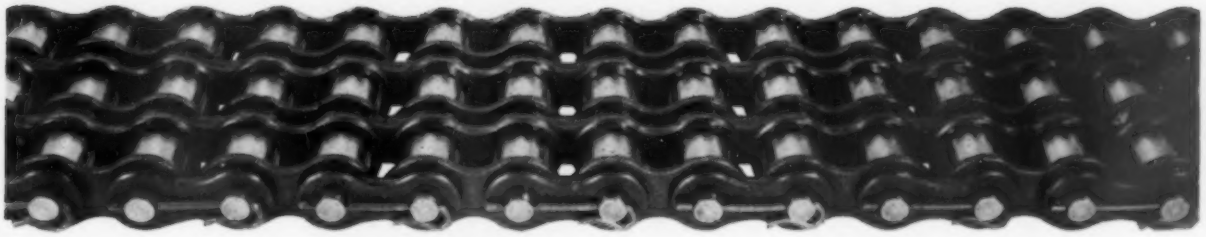
PULLING • A fully retrievable packer, the HS-16-1 can be rerun after servicing. The cost of drilling and replacing a permanent-set packer is eliminated. • Swabbing action while pulling is minimized by the built-in equalizing valve and the ample by-pass area around the packer.

All of this adds up to down-hole profits from savings of time and materials, and the plus profit of added safety. The Brown HS-16-1 packers are available in all popular sizes or to your specifications on special order. Just call one of our representatives – they serve production areas throughout the free world.

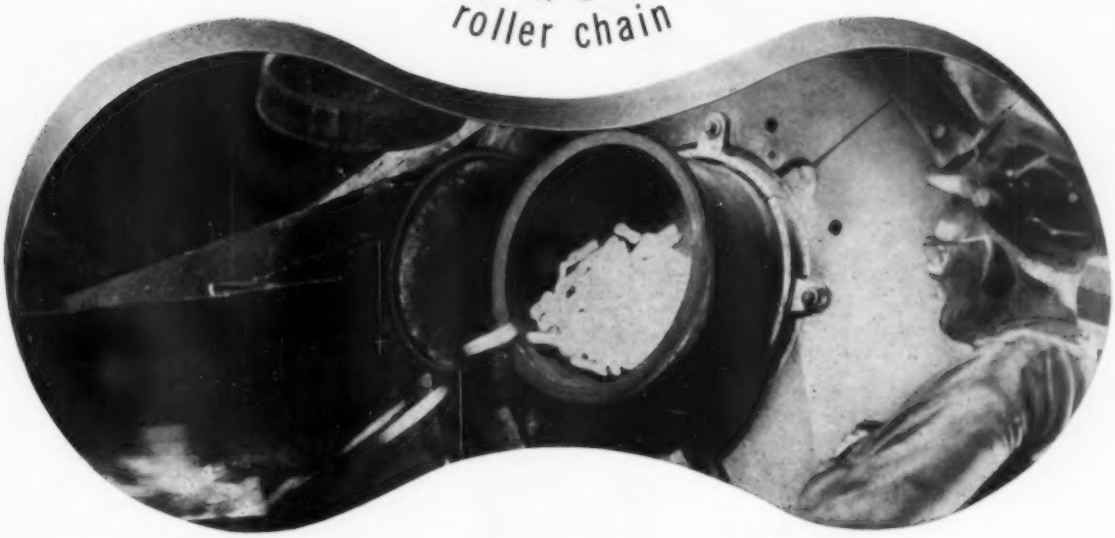
BROWN OIL TOOLS, INC.

8490 KATY ROAD P. O. BOX 19236,
HOUSTON 24, TEXAS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Another of the invisible extras that insure MORE ON-BOTTOM TIME with LINK-BELT FR® roller chain

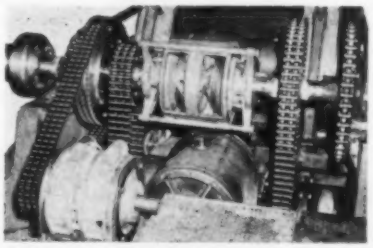


Painstaking precision of heat-treat control gives you

uniform strength in every link

To produce roller chain of utmost uniformity, Link-Belt maintains exacting control of all heat-treating processes. With equipment and instrumentation exactly tailored to the need, all processes are carefully adjusted to suit the characteristics of each heat and analysis of steel. Result: roller chain of uniform strength *well above accepted standards*. Chain that absorbs shock loads, delivers full power under continuous heavy going.

Precise heat-treat control is one of many *invisible extras* that contribute to the greater strength and endurance of Link-Belt roller chain. Others include prestressing, pitch-hole preparation, shot-peening. These features—plus painstaking precision and inspection in every step of manufacture—assure you of chain that can easily cope with today's heavy loads and high speeds.



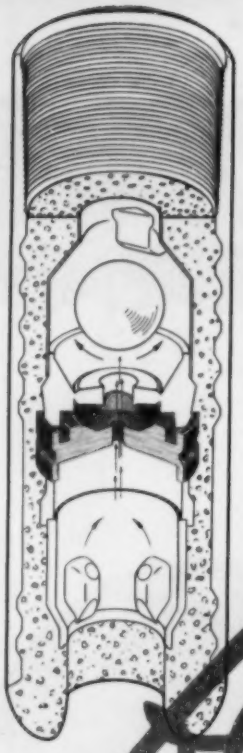
COMET PORTABLE DRILLING RIG, built by Cabot Shops, Inc., Pampa, Texas incorporates Link-Belt FR roller chain.

For engineering assistance in applying FR roller chain, write Link-Belt Company, Indianapolis 6, Indiana. Ask any leading supply store for our Catalog 2980 containing full information on roller chain and other oil field equipment.

LINK-BELT COMPANY: Indianapolis 6, Houston 1, Dallas 26, Odessa, Tex., New Orleans 16, Shreveport, La., Los Angeles 22 (Montebello), Scarboro (Toronto 13); Export Office, New York 7. Distributors in All Fields. 15,574

LINK-BELT

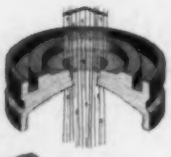
ROLLER CHAINS AND SPROCKETS



HERE'S HOW the FLEXIFLOW Variable Valve automatically fills casing from the bottom...

A When casing is lowered, pressure from below causes the hole in the reinforced synthetic rubber disc to open wider, and fluid enters the casing, thus preventing build-up of pressure surges.

B As the rate of lowering the casing is slowed down (to set the joint in the slips) pressure from below decreases; the hole in the Variable Valve diaphragm contracts; fluid volume entering the casing is reduced and overfill is avoided.



ECONOMICAL

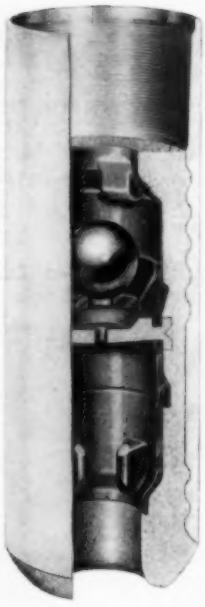
flexiflow

AUTOMATIC FILL-UP MEANS

NO SURFACE FILLING

CASING ON BOTTOM SAFER AND FASTER

PROTECTION OF PRODUCTIVITY



When pressure builds up as casing is lowered in the well, the Variable Valve in Baker FLEXIFLOW Shoes and Collars automatically opens wider and prevents pressure surges by permitting a large volume of fluid to enter the casing. As the rate of lowering is slowed down, pressure from below is lessened and the Variable Valve contracts to restrict fluid entry and prevent overfill. This automatic opening and closing action balances the *rate of fill* with the *rate of lowering* and prevents build-up of dangerous pressure surges.

Casing running time can be greatly reduced because Baker FLEXIFLOW Shoes and Collars save the time otherwise wasted in surface filling; and automatic "fill" permits the casing to be run faster without danger of damaging the formation by high-pressure surges. A back-pressure valve, for floating or cementing, is actuated by pressuring the casing.

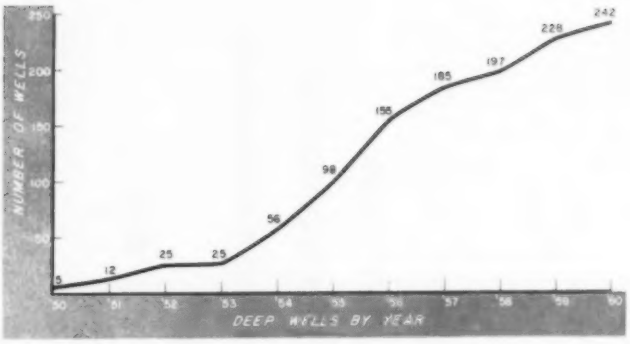
Ask any Baker representative how FLEXIFLOW Shoes and Collars (Regular or Circulating Type), used in combination with Baker CASING CENTRALIZERS and Baker WALL SCRATCHERS, bring you the safety and savings of Baker "Protective" Cementing.

BAKER OIL TOOLS, INC.
HOUSTON • LOS ANGELES • NEW YORK

For MORE than a good cement job, use Baker *FLEXIFLOW* Shoes and Collars in combination with Baker Casing Centralizers and Baker Wall Scratchers. *Available through your supply store.*

BAKER FLEXIFLOW
SHOES AND COLLARS

DEEP DRILLING INCREASED 6% IN 1960



Operators paid $165 million for 242 holes 15,000 ft and below to set all time record.

ERNESTINE ADAMS

OPERATORS PAID $165 MILLION for 242 deep wells drilled in the U. S. in 1960.

This brings total expenditures for all deep wells—1260 that have gone below 15,000 ft—to $850 million.

Despite high costs number of deep wells increased 6% over 1959 during a period when total drilling dropped about 9%.

And what have the operators got for their money?

They have found production below 15,000 ft in 56 fields—228 wells have been completed as producers (a few are shut-in gas wells) from formations below 15,000 ft.

Out of 1260 deep wells, they have completed 644 wells that produce from various depths (or are shut-in gas wells waiting on markets).

They have learned to handle deep operations so competently that

. . . record drilling time has been cut from 150 days in 1950 to 19 days in 1960.

. . . low bit record has dropped from 106 in 1950 to 16 bits in 1960.

. . . deepest production went from 15,530 ft in 1950 to 20,745 ft.

. . . total footage in deep wells went from 78,565 ft drilled in 1950 to 3,858,622 ft drilled in 1960.

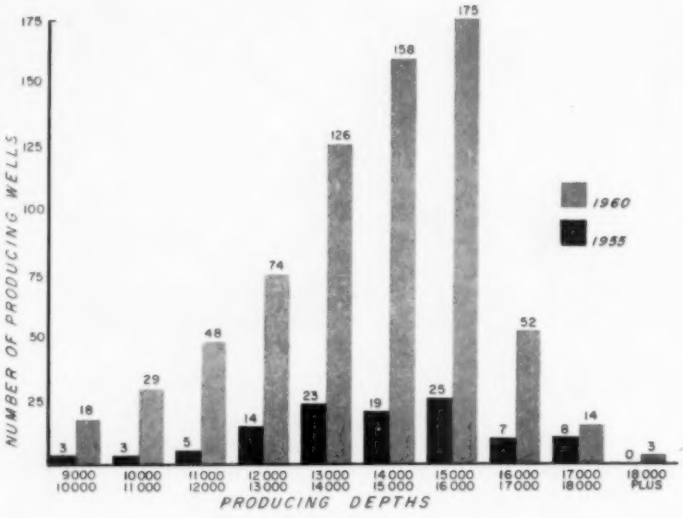
Variations in Costs

Average cost per well in 1960 was $674,000, compared to $650,000 last year. Costs per well ran from a record low of less than $170,000 to about $2

TABLE 1. WELLS COMPLETED 15,000 FT AND BELOW BY YEARS OF COMPLETION

Year	No. wells by date of completion	Explor-atory*	Pro-ducers	Average drilling time	Record drilling time	Average bits per well	Low bit record	Mud costs, average	Well costs, average	Average costs per ft	Total footage drilled	Ft/well average	Deepest well	Deepest producer
1938	1	1	1	—	284	—	195	—	—	—	15,004	—	15,004	13,175
1944	1	1	0	—	—	—	—	—	—	—	15,279	—	15,279	13,175
1945	3	3	0	490	—	222	—	—	—	—	63,480	15,870	16,655	13,175
1946	1	1	1	—	349	—	184	—	—	—	15,452	—	16,655	13,175
1947	8	8	1	267	121	181	73	$ 24,000	$570,000	$35.87	127,128	15,891	17,823	13,904
1948	7	6	2	328	113	303	99	28,000	551,000	34.34	112,329	16,047	17,823	14,255
1949	11	8	5	222	95	199	120	64,000	534,000	32.52	180,631	16,421	20,521	15,530
1950	5	2	3	235	150	181	106	63,000	577,000	36.72	78,565	15,713	20,521	15,530
1951	12	5	6	178	96	116	69	54,000	527,000	33.56	189,864	15,822	20,521	15,530
1952	25	17	9	212	83	138	44	66,000	549,000	34.77	396,850	15,874	20,521	16,012
1953	25	14	20	213	70	159	48	75,000	729,000	44.79	402,936	16,117	21,482	17,895
1954	56	30	31	182	71	117	40	92,000	651,000	40.87	892,021	15,929	21,482	17,895
1955	98	63	43	147	37	87	44	116,000	649,000	40.09	1,587,008	16,031	22,559	17,895
1956	155	77	78	150	36	89	31	122,000	683,000	42.18	2,510,050	15,988	22,559	20,745
1957	185	114	89	157	48	89	30	121,000	743,000	46.25	2,987,841	16,064	22,559	20,745
1958	197	136	100	130	34	79	24	107,000	692,000	43.18	3,171,762	16,019	25,340	20,745
1959	228	142	119	114	30	71	25	83,000	650,000	40.48	3,660,857	16,056	25,340	20,745
1960	242	134	136	105	19	66	16	86,000	675,000	42.50	3,858,622	15,945	25,340	20,745
Overall	1260	762	644	—	19	—	16	$ 99,000	$675,000	—	20,265,679	16,084	—	—

*Includes field wildcats.



The five years total producing wells from deep drilling has grown rapidly. All these wells have been drilled to 15,000 ft and below.

million. An unusual number of wells went over $1 million because of special circumstances, some connected with redrilling.

Costs were lowered in several states. Average cost per well in California dropped $39,000 each to $557,000; in Mississippi $6000 each to $545,000; in New Mexico $61,000 to $857,000; in Oklahoma $75,000 to $840,000. Costs in Texas and Louisiana rose slightly.

Enough cost data were available for 1960 to show differences in cost by depth: Wells

15,000-16,000 ft averaged $605,000.
16,000-17,000 ft averaged $756,000.
17,000 ft plus averaged $838,000.

As for mud costs you'd hardly be surprised to learn that they ran from $15,000 to $330,000 per well in 1960. The overall average was $86,000, slightly above 1959. Mud costs were reduced in California, Louisiana, Mississippi and Oklahoma.

Producing Depths of New Wells

Every year brings more emphatic evidence that deep drilling brings deep production. The record is impressive. Of the total of 1260 wells that have been drilled below 15,000 ft, 644 of them found oil. Add to these 47 wells that have had dual or triple completions and you have a high ratio of success.

Chart No. 2 reveals the spectacular work of the last five years. On the left is the record up to and including 1955. Bars at right show total number of producers from various depths found by deep wells up to December 31, 1960.

Successful deep wells in 1960 added 12 new fields to those that produce from below 15,000. This brings to 56 the number of fields in the United States that are producing or have produced from that depth. Seven states have deep fields.

New Deep Fields

For the first time since 1953 a deep field was added in California. Standard of California drilled a field wildcat, Burson No. 1, in the Fillmore area which is producing oil from 15,213-343 ft in the Spalding sand.

In Louisiana, California Company (Standard of California) discovered a new field at 15,185-116 ft in South Mermentau, Acadia parish. Initial production was 320 b/d condensate and 4200 mcf/d gas.

In the South Thornwell field, Cameron parish, Louisiana, one of the Hunt Group drilled to 18,029 ft and extended production of gas to a new depth, 14,994-15,014 ft.

Pan American drilled to 16,302 ft in the Raceland area, Lafourche Parish, and found gas at 14,974-15,063 ft.

TABLE 2. LOCATION AND AVERAGES OF WELLS DRILLED 15,000 FT AND BELOW

State	Number wells 1960	Total 15,000 ft holes	Completed as producers	Drilling time average days	Low drilling time record	Average bits per well	Low bit record	Deepest hole	Mud costs, average	Well cost average
Alaska	0	1	0	—	—	—	—	—	—	—
Alabama	0	3	0	225	191	178	28	15,729	$ 55,000	$ 511,000
California	7	61	14	163	44	153	56	21,482	73,000	557,000
Colorado	0	3	2	226	90	179	94	17,033	74,000	603,000
Florida	1	3	0	—	97	—	74	15,474	40,000	1,217,000
Louisiana	189	950	528	98	19	66	18	22,570	97,000	656,000
Mississippi	4	26	11	185	83	126	76	20,450	54,000	545,000
New Mexico	2	17	11	317	222	232	172	17,555	126,000	857,000
North Dakota	1	1	1	—	—	—	—	15,135	—	—
Oklahoma	10	45	20	287	40	212	36	24,004	105,000	840,000
Texas	27	140	53	210	44	127	16	25,340	118,000	755,000
Wyoming	1	10	4	385	318	252	199	20,521	74,000	904,000
TOTALS	242	1260	644		19		16	25,340		

TABLE 3. FIELDS AND PRODUCTION 15,000 FT AND BELOW

First deep production	Date found	Field	County or Parish	Wells drilled below 15,000 ft.	Wells with production below 15,000 ft.	Deepest production ft.
CALIFORNIA						
Richfield	1953	N. Coles Levee	Kern	1	1	17,895
Standard Calif.	1949	Wasco	Kern	3	1	15,530
Standard Calif.	1960	Fillmore	Ventura	13	1	18,420
LOUISIANA						
California Co.	1960	So. Mermentau	Acadia	2	1	15,116
Tidewater	1956	Rayne Lane Well	Acadia	10	1	15,270
Union Producing	1956	Deep Lake	Cameron	9	2	15,410
Tidewater	1959	Lacassine	Cameron	2	1	16,130
Hunt	1960	So. Thornwell	Cameron	4	1	15,014
Humble O & R	1956	Avery Is.	Iberia	4	3	15,496
Shell	1952	Weeks Is.	Iberia & St. Mary	44	39	17,745
Texaco	1954	Queen Bess Is.	Jefferson	7	4	16,149
Union O&G of La.	1956	Lake Arthur	Jefferson Davis	9	3	15,784
Caroline Hunt Sands	1958	So. Thornwell	Jefferson Davis & Cam.	10	2	15,398
Texaco	1956	Bay de Chene	Lafourche & Jefferson	7	2	15,500
Gulf Oil	1956	Timbalier Bay	Lafourche	15	3	17,260
Pan American	1960	Raceland	Lafourche	4	1	15,063
Pan American	1960	Lake Raccouri	Lafourche & Terrebonne	5	2	16,370
Grande Corp.	1957	St. John	Lafourche	6	3	15,420
John Mecom	1959	Home Place	Plaquemines	1	1	15,314
John Mecom	1954	Lake Washington	Plaquemines	36	9	20,745
Tidewater	1956	Venice	Plaquemines	7	3	16,060
Pan American	1958	Bastian Bay	Plaquemines	20	3	15,335
Gulf	1960	W. Delta Blk 27 SS	Plaquemines	9	3	15,200
Sid Richardson Car.	1956	Cade	St. Martin	2	1	15,085
Sun Oil	1958	Belle Isle	St. Mary	19	3	17,580
Texaco	1954	Cote Blanche Is.	St. Mary	25	10	17,000
Sunray Mid-Con.	1959	East Lake Sands	St. Mary	2	1	15,040
Humble O & R	1958	Eugene Is. SS	St. Mary	18	2	15,885
Wm. T. Burton	1959	Lake Palourde	St. Mary	3	1	15,679
Quintana	1959	Garden City	St. Mary	4	3	15,060
Humble	1960	Bayou Jean la Croix	Terrebonne	2	1	15,232
Superior Oil	1956	Bayou Rambio	Terrebonne	7	2	15,034
Texaco	1956	Caillou Is.	Terrebonne	42	10	16,116
Pan American-Hunt	1957	Block 39 SS	Terrebonne	1	1	16,842
Shell	1959	Block 139 SS	Terrebonne	8	5	15,032
Texaco	1954	Dog Lake	Terrebonne	6	2	15,879
Superior Oil	1956	Four Isle Dome	Terrebonne	15	12	16,908
Texaco	1956	Lake Barre	Terrebonne	35	25	17,288
Sun Oil	1956	Lake Pelto	Terrebonne	21	8	16,325
Placid	1956	Lapeyrouse	Terrebonne	23	15	16,100
Superior	1960	South Sunrise	Terrebonne	1	1	16,694
Sid Richardson	1957	Abbeville	Vermilion	7	1	15,012
Superior	1960	Lac Blanc	Vermilion	1	1	16,362
Union O&G of La.	1958	Leleux	Vermilion	4	1	16,928
Gulf	1959	Redfish Point	Vermilion	4	2	15,516
Sid Richardson Car.	1958	Riceville	Vermilion	6	3	15,880
MISSISSIPPI						
Gulf	1958	Soso	Jasper	3	1	15,256
NEW MEXICO						
Continental	1955	San Simon	Lea	1	1	15,025
OKLAHOMA						
British American	1956	Carter-Knox	Grady & Stephens	14	10	17,382
Pasotex	1960	—	Love	1	2	15,194
Gulf Oil	—	New Hope	McClain	1	1	18,944
TEXAS						
Pure Oil	1959	S. Hitchcock	Galveston	1	1	16,264
Standard Texas	1959	—	Grayson	1	1	16,550
Phillips	1953	Puckett-Ellenbgr.	Pecos	5	5	15,324
Atlantic	1960	Hershenson	Pecos	1	1	16,820
Mobil	1960	—	Pecos	1	1	15,147
WYOMING						
Pure	1952	W. Poison Spider	Natrona	2	2	16,102
Pure	1957	Badwater	Natrona	2	1	16,477
TOTAL		**56 Fields**	**7 States**	—	**228**	**20,745**

Initial production was 262 b/d of 35.8 gravity oil and 3500 mcf/d.

Pan American also discovered gas at 15,606-16 ft in Lake Raccourci field, Lafourche Parish, Louisiana. Soon after Texaco brought in new gas pay sand at 16,363-70 ft in the same field.

Superior Oil found deep production in the Lac Blanc field, Vermilion Parish. It is producing below 16,000 ft, a gas condensate well with initial production with 88 b/d condensate and 8062 mcf/d gas.

Humble extended Bayou Jean la Croix field with a new sand at 15,232 ft in Terrebonne parish. Initial production was 345 b/d oil and 3015 mcf/d gas.

In West Delta Block 27, offshore Plaquemines parish, Gulf found new production below 15,000 ft with two different wells; both extended the field. The largest one produced 505 b/d condensate and 9700 mcf/d gas.

Superior Oil's wildcat at South Sunrise went to 17,070 ft and perforated at 16,684-94 ft to discover gas. Initial production was 5704 mcf/d gas.

Pasotex Petroleum Company discovered a new deep field in Love County, Oklahoma, southeast of Marietta. The test well went to 15,679 ft; is producing gas from 13,889-15,679 ft. Initial production was 25 b/d condensate and 1800 mcf/d gas.

Two Deep Fields in Texas

Texas has two new discoveries below 15,000 ft in Pecos county. Mobil Oil drilled the No. 1 Kathleen J. Moore to 15,300 ft and made a gas discovery in the Pennsylvanian at 15,041-47 ft. Open flow was 105,000 mcf/d and bottom hole shut in pressure was 12,590 psi. The well had a blow-out and was redrilled. Drilling time was 387 days.

Atlantic Refining discovered a new field in the Hershenson area with its No. 1 J. C. Kelly. The wildcat was drilled to 19,696 ft and plugged back to 16,820 in the Devonian Ellenberger. The well is still shut in waiting on special tubing before an official test can be taken.

There were several field extensions added to deep fields. One was in St. John field, Lafourche parish, where Grande Corporation extended the field to a deeper sand at 15,396-420 ft.

Shell Oil found new oil pay at 15,016-32 ft in Ship Shoal Block 139, Terrebonne parish. This was a deep gas field.

Union Producing Company found a new gas pay at 15,299-325 ft in the Lapeyrouse field in Terrebonne parish.

In Bastian Bay, Plaquemines parish, F. A. Callery drilled a dual gas well which extended the field. Production is at 15,256 ft and below.

TABLE 4. DEEP WELL OPERATORS

Operator	Wells drilled 1960	Wells drilled before 1960	Total
Abercrombie, J. S.	0	1	1
Alcoa	0	2	2
Amerada	1	0	1
American Petrofina	0	1	1
Anderson-Prichard	0	1	1
Atlantic Refining	1	5	6
Austral Oil Explor.	1	8	9
Belle Isle Corp.	0	1	1
Block 27 Assoc. Ltd.	0	1	1
Brazos Oil & Gas Co.	0	2	2
British American	1	18	19
Brown, Geo. A.	0	3	3
Brown, J. W.	0	1	1
Buffalo Oil	0	1	1
Burton, Wm. T., Ind.	1	5	6
California Co.[1]	6	14	20
Callery, Inc., F.A.	1	3	4
CATC	0	2	2
Chacahoula O&G	0	1	1
Cities Service	0	6	6
Clegg & Hunt	1	0	1
Cockrell, E. C.	1	1	2
Cole, H. S., Jr.	0	1	1
Columbian Carbon	0	2	2
Continental Oil	2	24	26
Denver Prod. & Ref.	0	1	1
Drilling & Explor.	0	2	2
Ellison, Kenneth	1	0	1
El Paso Natural Gas	0	2	2
Flaitz, J. M. et al	1	1	2
Frankfort Oil Co.	0	3	3
Gamble, B. E.	1	0	1
General Crude Oil	2	0	2
Ginther, Warren & Co.	0	2	2
Grande Corp.	3	8	11
Gulf Oil Corp.	15	56	71
Hawkins, H. L.	0	1	1
Houston Oil	0	1	1
Huber, J. M. Corp.	0	1	1
Humble Oil & Ref.	16	62	78
Hunt Group[2]	8	22	30
Husky Oil	0	1	1
Kerr-McGee	1	2	3
Kilroy Co.	1	0	1
LaGloria Corp.	0	1	1
Lamson, Bennett, Cole	0	1	1
Little Nick Oil Co.	0	1	1
Lloyd Corp.	0	5	5
Lone Star Producing	0	3	3
McDermott, J. Ray	3	3	6
Mayfield, M. L.	0	1	1
Mecom, John W.	4	37	41
Midwest Oil Corp.	1	0	1
Mississippi River Fuel	2	4	6
Mobil Oil	5	38	43
Monsanto (Lion)	1	2	3
Mountain Fuel Supply	0	1	1
Ocean Drlg. & Expl.	1	0	1
Ohio Oil Co.	0	1	1
Olin Gas Trans.	0	4	4
Owen, J. P.	0	2	2
Pacific Western	0	1	1
Pan American	6	55	61
Pano Tech Explor.	1	1	2
Pasotex Petroleum	6	1	7
Pet. Offshore Leaseholds	1	0	1
Phillips	1	42	43
Placid Oil Co.[2]	15	32	47
Pray, Max	0	3	3
Pure Oil Co.	3	10	13
Quintana	3	2	5
Republic Natural Gas	0	1	1
Richardson & Bass	0	34	34
Richfield Oil	0	4	4
Rutter & Wilbanks	0	1	1
San Jacinto O&G	1	1	2
Shell Oil Co.	25	70	95
Shoreline Exp.	1	2	3
Sinclair	3	10	13
Skelly	0	2	2
Sohio	2	1	3
Southern Nat'l Gas	1	0	1
Standard of Calif.	3	19	22
Standard of Texas[1]	0	4	4
Sun Oil Co.	7	29	36
Sunray Mid-Cont.	1	9	10
Superior Oil Co.	14	47	61
Sutton Prod. Co.	0	1	1
Tennessee Gas Trans.	1	1	2
Texaco	43	172	215
Texam Oil	1	0	1
Texas Crude Oil Co.	1	0	1
Texas Eastern Trans.	0	2	2
Texas Gas & Gasoline	0	1	1
Texas Gulf	0	2	2
Texas Pacific C & O	0	1	1
Thayer, David S.	1	1	2
Tidewater Oil	3	26	29
Trahan, J. N., Drlg.	0	1	1
Trice Prod.	1	0	1
Trunkline Gas-Cyprus	0	1	1
Union of California	6	23	29
Union Producing Co	5	9	14
Union Texas Natural Gas	4	19	23
Vasen, George	0	1	1
Western Natural Gas	0	2	2
Zapata Petroleum	0	1	1
TOTALS	242	1018	1260

[1]Standard California affiliate.

[2]H. L. Hunt companies.

A new gas sand was added in Lake Pelto by Clegg and Hunt at 16,057-67 ft. Initial production was 372 b/d condensate and 5173 mcf/d gas. Sun Oil, which discovered the Lake Pelto field, Terrebonne parish, found a new production depth at 16,325 ft. This well was redrilled directionally after temporary abandonment.

Three Came Close

Three other new fields discovered by deep wells come close to 15,000 ft. Shoreline Exploration found 2500 mcf/d at 14,843-49 ft in Iberia parish, Louisiana.

A strike was made in Vermilion parish, Louisiana, by Tennessee Gas Transmission at 14,716-32 ft in A-1 sand. Initial production was 185 b/d condensate and 4900 mcf/d gas. The company reentered an old well at 13,146 ft and drilled to 15,856 ft.

Continental Oil made a gas discovery in Lea County, New Mexico, at 14,568-829 ft, after drilling to 16,506 ft. Production was estimated at 36 b/d condensate and 30,500 mcf/d gas.

Field Discoveries

In all, 22 new fields were brought in by wildcats drilled below 15,000 ft. Some pay sands were in shallow depths.

Field wildcats (depth wildcats) brought in 19 new pay sands and stepouts found pay in 19 wells that extended the area of the field. Number of dry wildcats and semi-wildcats were 80. This is an extraordinary record but as we've pointed out before tests in depth can hardly be compared to shallow tests.

Field wells had a record of 76 producers to 26 dry holes.

Of the 242 wells drilled below 15,000 ft, 136 were completed as producers or shutin gas wells waiting on markets. Also 17 of these were completed as dual producers.

Deep Well Operators

In 1960 seven operators were added to the list of oil and gas companies which had deep wells. There are now 107 operators on this list.

Texaco continues to lead all operators in number of deep wells drilled, the company now has a total of 216.

Shell comes second with 95. If the

TABLE 5. RECORD DRILLING DEPTHS BY YEAR

	TD, ft
1938—Continental KCL, A-2, Wasco field, Kern County, California	15,004
1944—Phillips No. 1 Ada Price, Pecos, Texas	15,279
1945—Standard of California KCL 20-13, So. Coles Levee, Kern, California	16,246
1945—Phillips No. 3 Schoeps, Brazos, Texas	16,655
1947—Pacific Western No. 1 National Royalties, Miramontes, Kern, California	16,668
1947—Superior Oil Weller 51-11, Caddo, Oklahoma	17,823
1949—Superior Oil Limoneria No. 1, Montalvo, Ventura, California	18,734
1949—Superior Oil Pacific Creek No. 1, Sublette County, Wyoming	20,521
1953—Ohio Oil KCL No. "A" 72-4, Kern County, California	21,482
1956—Richardson and Bass L.L.&E. I-L St. Lse 2414, Plaquemines Parish, Louisiana	22,570
1958—Phillips No. 1-EE University, Pecos, Texas	25,340

Hunt Group and Placid, which is also an H. L. Hunt company, are combined, we have the third largest number of deep wells, which is 79. Humble is next with 73; Gulf, fifth with 69; Pan American, sixth with 63. John Mecom, Mobil Oil and Phillips each have drilled 43 wells below 15,000 ft.

We pointed out repeatedly that most deep holes are shared by two or more interests. Sometimes five or six companies will bear the cost. An important product of deep drilling is information and sometimes this is the best way to get it.

Drilling Time

Average drilling time in 1960 for deep wells cut off nine days per well and brought the overall average to 105 days. This included some wells that required over a year to drill as well as the all-time record breaker which took 19 days to get to 15,082 ft. This is Shell's offshore well in South Timbalier, Block 76. Previous record drilling time for deep wells was 30 days.

Mobil Oil's deep well in North Custer City, Custer County, went to 15,083 ft in 40 days, which is Oklahoma's all-time record. Previous low drilling time was 165 days.

Low drilling time in Texas was reduced from 50 days to 44 days. A Shell wildcat in Jefferson County went to 15,457 ft in 44 days, using only 16 bits.

Bits For Deep Wells

Five bits per well were paired from the average used on deep wells in 1960. From 77 in 1959, average bits used per well dropped to 66.

Shell made a new low record for bits in its Hebert Ranch wildcat, Jefferson County, Texas, using 16 bits to go 15,457 ft (same well that gave Texas its record drilling time). The same company brought the Louisiana record down from 24 to 18 bits — the number used on the well which took only 19 days to drill.

One of the most decisive changes in the low bit record was in Oklahoma where Kenneth A. Ellison's wildcat in Caddo County went to 19,695 ft with only 36 bits. Previous record was 128. The 36 bits included 4 diamond core heads and 14 diamond bits. This cuts the record almost in one-fourth.

The Florida record was reduced by one-half to 74 bits used. This Gulf well was the only one drilled in Florida.

Drilling Contractors

In our listing of deep well contractors who drilled wells below 15,000 ft in 1960 are 23 companies not on the list last year. Considering the equipment and experience necessary for deep drilling, the continual additions to our list of contractors with suitable equipment is evidence that at least one section of the service industry is keeping up with deep drilling needs.

In 1960 alone, 56 contractors drilled one or more of these super-deep wells.

What's Coming

Increase in deep drilling has been consistent and healthy. We estimate 1961 will see another 255 to 260 new holes drilled below 15,000 ft and cumulative expenditures for deep drilling will pass the billion-dollar mark.

It would be interesting to calculate returns on the huge investment in deep wells. From what production records we have, it appears the capital outlay will pay off eventually. This prediction is influenced by growing evidence of deep offshore production.

Condensate-gas from the majority of deep producers means that natural gas prices will be a big factor in payout.

Real price reduction is not going to be easy, for deep exploratory wells are the prima donnas of the drilling business. Even in field wells where conditions are well known, you can have an obstreperous actor that costs a mint. Yet progress is shown in the fact that record low cost keeps going down and the number of wells costing less than $450,000 grows faster than total deep wells.

Also we are running into directional drilling at great depths, which means that from 13,000 ft, for instance, four or five holes can be drilled below 15,000 ft. These account in large degree for higher costs this year.

Deep drilling is taking on a more professional hue. It's getting to be a common project. Can you imagine that 10 years ago only 5 holes were drilled below 15,000 ft; 5 years ago the number reached 98 deep holes. By 1965, deep wells will probably average one a day. ★ ★ ★

TABLE 6. DEEP WELL DRILLING CONTRACTORS FOR 1960

A & P Drlg. Co. Inc.
Oklahoma City, Okla.

Bay Drlg. Co.
Thibodeaux, La.

Bayou Drlg. Co.
Houston, Texas

Big Chief Drlg. Co.
Okla. City, Okla.

Bilbo-Redding Drlg. Co.
Houston, Texas

Bluewater Drlg. Corp.
New Orleans, La.

Brewster-Bartle
Houston, Texas

Bullard Drlg. Co.
Houston, Texas

Circle Drlg. Co.
Lake Charles, La.

Clegg & Hunt
Houston, Texas

Cron & Gracey Corp.
Houston, Texas

Delta Marine Drlg. Co.
Tyler, Texas

Dillard-Waltermire
Wichita Falls, Texas

Dixie Drlg. Co.
Dallas, Texas

Dixilyn Drlg. Co.
Odessa, Texas

Edwards Drlg. Co.
Houston, Texas

Falcon-Seaboard
Tulsa, Okla.

Foster Drlg. Co.
Houston, Texas

Gordon Drlg. Co.
Lake Charles, La.

Gracey-Hellums
Houston, Texas

Great Western Drlg.
Midland, Texas

Gulf Marine Drlg.
Morgan City, La.

Helmerich & Payne
Tulsa, Okla.

Hershey Drlg. Co.
New Orleans, La.

Kerr-McGee
Okla. City, Okla.

K. L. Kellogg & Sons
Compton, Calif.

Kelly Drlg. Co.
Houma, La.

King Drlg. Co.
Midland, Texas

Larco Drlg. Co.
Jackson, Miss.

Loffland Bros. Co.
Tulsa, Okla.

Mac Drilling Co.
Houston, Texas

Maxwell Herring Drlg.
Tyler, Texas

Meadows & Walker
Houston, Texas

R. B. Montgomery
Bakersfield, Calif.

Nicklos Drlg. Co.
Houston, Texas

Noble Drlg. Co.
Tulsa, Okla.

Ocean Drlg. & Exp.
New Orleans, La.

Offshore Drlg. Co.
Baton Rouge, La.

Owens Drlg. Co.
Lafayette, La.

Parker Drlg. Co.
Tulsa, Okla.

Penrod Drlg. Co.
Dallas, Texas

Power Rig Drlg. Co.
Lafayette, La.

Producers Drlg.
New Orleans, La.

Rimrock Tidelands, Inc.
New Orleans, La.

Grady Roper
Lake Charles, La.

Rowan Drlg. Co., Inc.
Fort Worth, Texas

Sharp Drlg. Co.
Midland, Texas

Sharp-Gulf Drlg. Co.
New Orleans, La.

M. A. Smith Drlg. Co.
New Orleans, La.

Southeastern Drlg.
Dallas, Texas

Steen Drlg. Co.
Houston, Texas

Thirteen Drlg. Co.
New Orleans, La.

C. B. Webster Drlg.
Houston, Texas

Fred Wilson Drlg. Co.
Shreveport, La.

Worley & Harrell, Inc.
Tulsa, Okla.

Yates Drilling Co.
Lafayette, La.

Zapata Offshore
Houston, Texas

THANKS TO DEEP WELL OPERATORS

this survey is possible. We have had excellent cooperation in gathering the information collected here. Our sincere appreciation goes to the oil companies that provide essential data. We are especially grateful for cost figures because our readers say these are helpful operating economics.

EDITOR'S NOTE

Table 7, describing each deep well separately, will be published in the next issue.

FIG. 1. Large billboard greets visitors to the Miller-Long Unit No. 1 in Oklahoma's Anadarko Basin. Diagram in center is geological section in area and shows proposed completion in the Bromide sands at approximately 21,150 ft.

Welcome Folks
MILLER-LONG UNIT No1
Location - NW NW SE, Section 4, T9N, R12W
Caddo County, Oklahoma
Owners - K.A.Ellison & Associates • Tekoil Corp.
Northern Nat. Gas Co. • Reiter-Foster Corp.
Mineral Mining Co. • Bradley Prod. Corp.
Contributors - Many local royalty & landowners
- Superior Oil Co. • Continental Oil Co.
The Grande Corp.
Drilling Contractor
- Parker Drilling Co.
Operator - K.A.Ellison, Oklahoma City

Three and one-half years and $4 million have gone into the search for deep production in this Anadarko Basin well. Twice abandoned, the well will be re-entered this month

SIDETRACKS MARK TOUGH

LOWELL A. MURPHY, *Assistant Editor*

ON NOVEMBER 10, 1957, the attention of the drilling industry was drawn to a new venture getting underway in Oklahoma's Anadarko Basin. On that day, the Anadarko Basin No. 1 in Caddo County was spudded as the first step of the program which was designed to carry the well to the bottom of the vast sedimentary basin, looking for production from the Bromide sand. Drilling was being done by Howell & Howell (now the Grande Corporation), producers and drilling contractors, and co-owners of the project with Tekoil Corporation, Gulf Oil Corporation, Baruch-Foster Corporation, and Kenneth A. Ellison & Associates.

For nearly two years, the giant rig worked to push the bit to the objective formation, estimated to be at about 21,150 ft. But on August 2, 1959, after a long series of costly mishaps, the hole was abandoned after drilling to 21,021 ft, heart-breakingly near the target depth. (See *The Petroleum Engineer*, March 1960, p. B-31.)

Hole Re-entered

Soon after this operation stopped, Kenneth A. Ellison began to explore the possibilities of re-entering the hole and deepening it at least to the Hunton limestone. He received little encouragement and several operators advised him that it would be impossible to re-enter the hole and reach the Hunton through any method.

Ellison then approached Parker Drilling Company with his proposal and together they studied the problems involved before agreeing that it was a practical possibility. Parker developed two possible drilling programs and made estimates of time and money needed, realizing that each step depended upon the success or failure of the previous step.

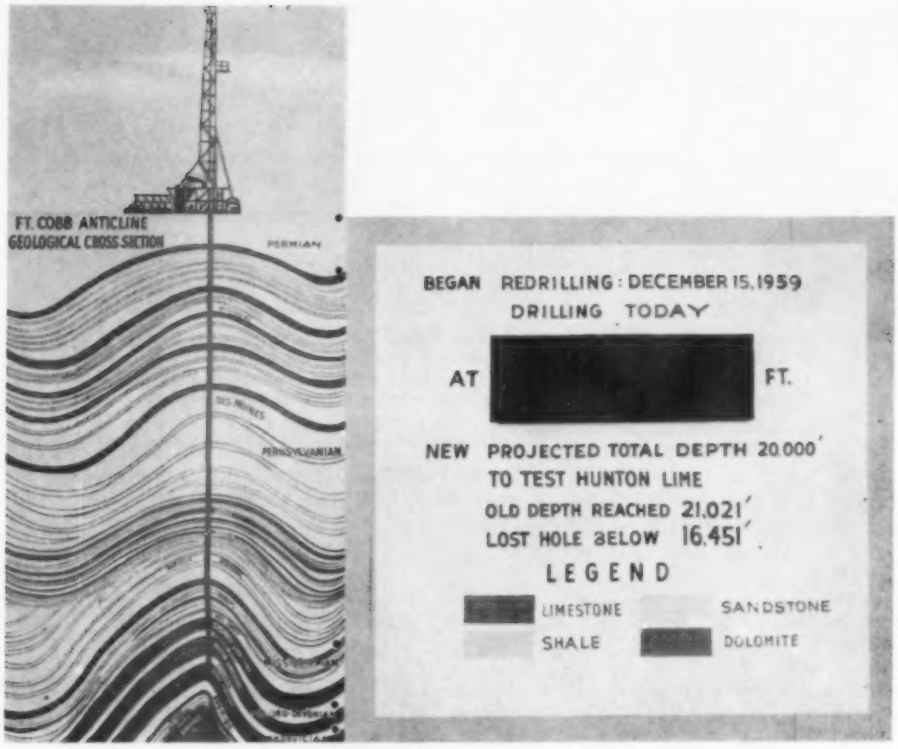
Finally, the preliminary plans were completed and Parker Drilling Company moved its electric rig No. 57 onto the location. The well had been renamed No. 1 Miller-Long Unit and working interests in the project were held by Northern Natural Gas Producing Company, Tekoil Corporation, Mineral Mining Company, Baruch-Foster Corporation, Bradley Producing Corporation, and Kenneth A. Ellison & Associates. On December 15, 1959, the cement plug at the surface was drilled out and the well was once more active.

Cleanout operations continued until the well was milling at 16,545 ft where the bottom drill collar became stuck. Fishing operations failed to recover the collar and mill, so a bridge plug was set at 16,444 ft and a permanent whipstock was set with its top at 16,425 ft.

Window Cut at 16,425 Ft

A diamond head and core barrel were used to cut a window through the 7-in. and 9⅝-in. casing strings. After cutting 20 ft, the pipe was pulled and the core barrel was found to contain two slivers of pipe that had been cut from the two casing strings. In addition to the window, the core head had cut 7 ft of formation outside the pipe.

The diamond head and core barrel were run back into the hole to cut 12 ft more and then a three-cone rock bit was run. After drilling had passed 16,560 ft, hole conditions began to cause new problems. Sloughing shale required frequent mud conditioning and drilling was stopped periodically while the hole was circulated clean. Gas entering the hole increased and



ROAD IN DEEP OKLAHOMA WELL

was circulated out continuously with the mud. Then, on February 3, two drill collars and the bit were left on the bottom of the hole.

Fishing operations begun on the following day were unsuccessful and part of the fishing tools were left in the hole, leaving the top of the fish at 16,440 ft, just outside the whipstock. This junk forced the decision to set another whipstock up-hole and to start another sidetracked hole.

Difficulties in the first whipstock hole were believed to have resulted from the rather abrupt angle at which the window was cut. The diamond head used to cut the window also cut away part of the deflecting surface of the whipstock, increasing the angle of deflection to a point that caused the drill collars to fail.

On February 13, after conditioning the hole, a bridge plug was set at 16,370 ft and a whipstock was set with its top at 16,351 ft. A casing mill was used to cut a window in the 7-in. and 9⅝-in. casing strings and then a diamond corehead and core barrel were run to start the new hole.

When the tools were pulled from the hole, the diamond corehead and lower 43 in. of core barrel were left in the hole. This fish was removed from the hole with a conventional spear and drilling was resumed with a diamond bit.

As drilling progressed to 16,387 ft, the drill pipe appeared to be binding, indicating that the drift angle of the deviated hole was too sharp. A flat bottom mill was run to ream out the window into a more gradual drift angle. The diamond bit was then run back into the hole to resume drilling.

New Hole Follows Old

After the hole had reached 16,391 ft, the bit was pulled and found to have been badly scarred around the gage surface. This was determined to have been caused as the bit in the deviated hole drilled down beside the original hole and rubbed against the 9⅝-in. casing.

In an effort to deflect the whipstock hole away from the old hole, 50 sacks of cement were spotted in the deviated hole. When the cement was checked, it was found to have settled down the outside of the old hole around the 9⅝-in. casing. Another 50 sacks of cement were spotted in the hole and a 5-degree slimjoint was run to attempt displacement away from the old hole. But the cement was found to be honeycombed with gas and too soft to deflect the bit.

Two more batches of cement were spotted in the hole but attempts to deflect the hole were not successful. In an attempt to overcome the effects of gas entrained in the cement batches, a cement squeeze job was tried but the formation would not take the cement at 6000 psi.

Troublesome Hole Whipstocked

After these unsuccessful attempts to correct the deviated hole, the packer was drilled out, the hole was conditioned, and a retrievable whipstock was set at 16,365 ft. This depth was well above the troublesome spot, but still inside the deviated hole. A 4¾-in. diamond bit was used to drill to 16,387 ft. The whipstock was then pulled from the hole and drilling continued with a 4¾-in. rock bit to 16,395 ft.

A 5¾-in. tungsten carbide reamer was then run to enlarge the new hole

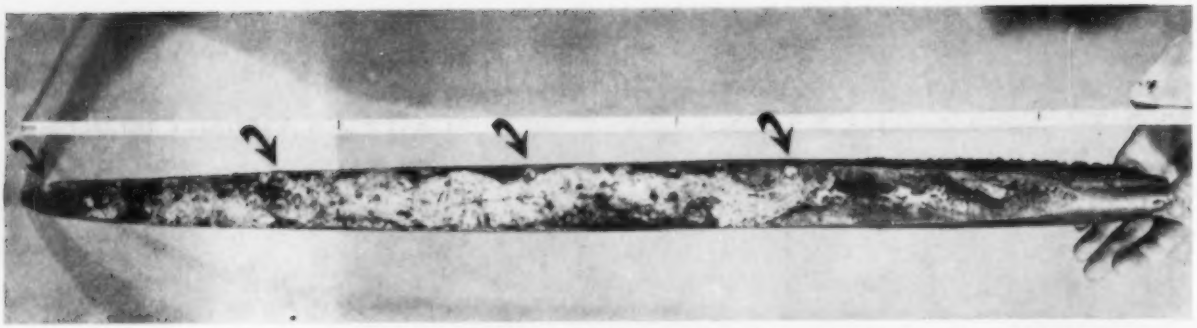


FIG. 2. Sliver cut from window in 9⅝-in., P-110 casing string at 16,425 ft tells interesting story. The 40-in. long piece of pipe bore four holes (arrows) which had been perforated with a jet gun. Cement bond with the pipe was excellent. There was no evidence of pipe shattering due to perforating or milling operations.

from 16,365 to 16,391 ft. At this depth, a trip was made to run in a diamond coring bit and core barrel. Drilling was resumed and had progressed to 16,396 ft when the bit stopped drilling. The pipe was pulled and the outer barrel was found to have parted, leaving the lower half of the outer barrel and the bit in the hole with the top of fish at 16,373 ft.

Three days of fishing failed to recover the parted barrel and bit before it was decided to try to mill up the fish. A tungsten carbide mill was built on the end of a drill collar and milled from 16,379 to 16,387 ft, but the mill was running outside the fish and did not remove any of the parted barrel. At 16,387 ft, the mill was pulled after it had quit drilling in a soft shale streak.

A "button" bit was then run and it too bypassed the fish in the hole without trouble.

By March 18, drilling had progressed without incident to 16,574 ft after making several trips for bit changes and without touching the parted core barrel left in the hole. At this depth, the hole had penetrated through the Springer sand and was drilling in the Goddard shale. The hole was in good shape and not troubled by gas or shale sloughing.

Good drilling continued with diamond bits making excellent footage and good penetration rates as the bit worked through shales, limey shales, and limestones of the Chester formations. On the first day of May, the hole was at 18,528 ft and drilling smoothly.

By Tuesday, May 10, the diamond bit in the hole was at 18,945 ft after drilling 348 ft in 148 hours. Penetration rate had decreased and it was decided to pull the bit and check the drill collars. Late that afternoon, all the drill pipe (195 stands of three joints each) had been racked in the derrick and one drill collar had been pulled, leaving 16 collars suspended in the hole on slips and a safety clamp. Suddenly,

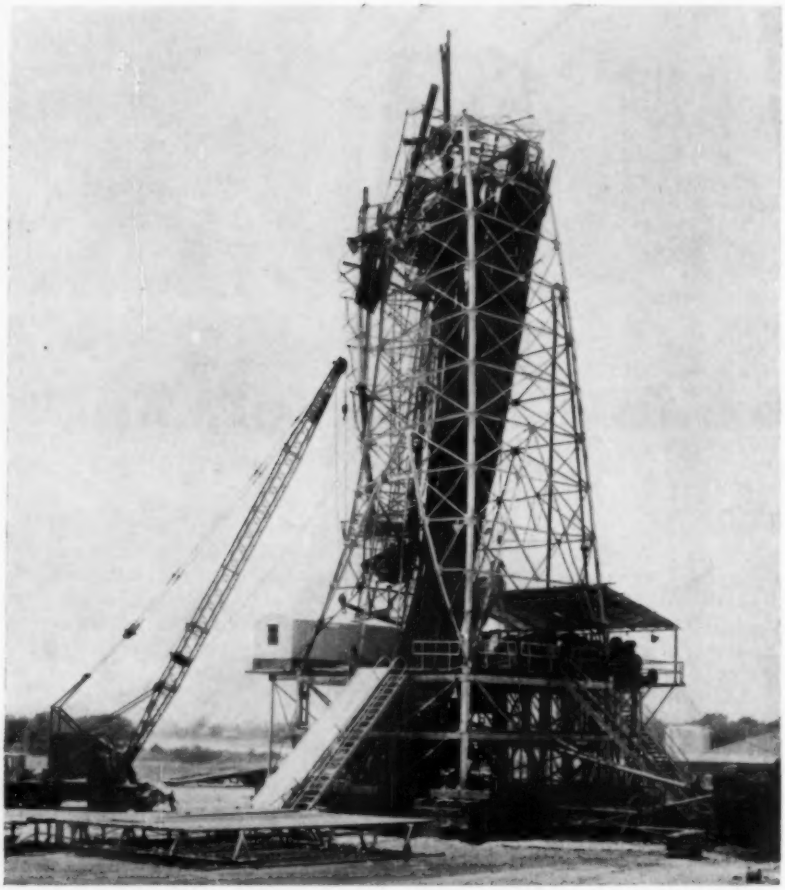


FIG. 3. Derrick-floor collapse brought near tragedy to drilling operations. With nearly all pipe stacked in derrick, floor gave way, dropping pipe and causing top of mast to topple over. Two crewmen were hurt, neither seriously. Huge cranes removed pipe from derrick before new derrick was built and operations resumed in one week.

near-disaster struck in a freak accident.

Rig Floor Collapse

The drill pipe in the derrick fell through the derrick floor. The upper mass of pipe toppled over and smashed against the opposite side of the derrick, buckling the derrick and causing the crown block and top 60 to 70 ft of derrick to jacknife and fall over against the lower part of the derrick where it was held by the drilling lines entangled with the drill pipe.

Miraculously, there were no critical injuries to personnel. The derrick man was injured and required hospitalization. One of the roughnecks fell

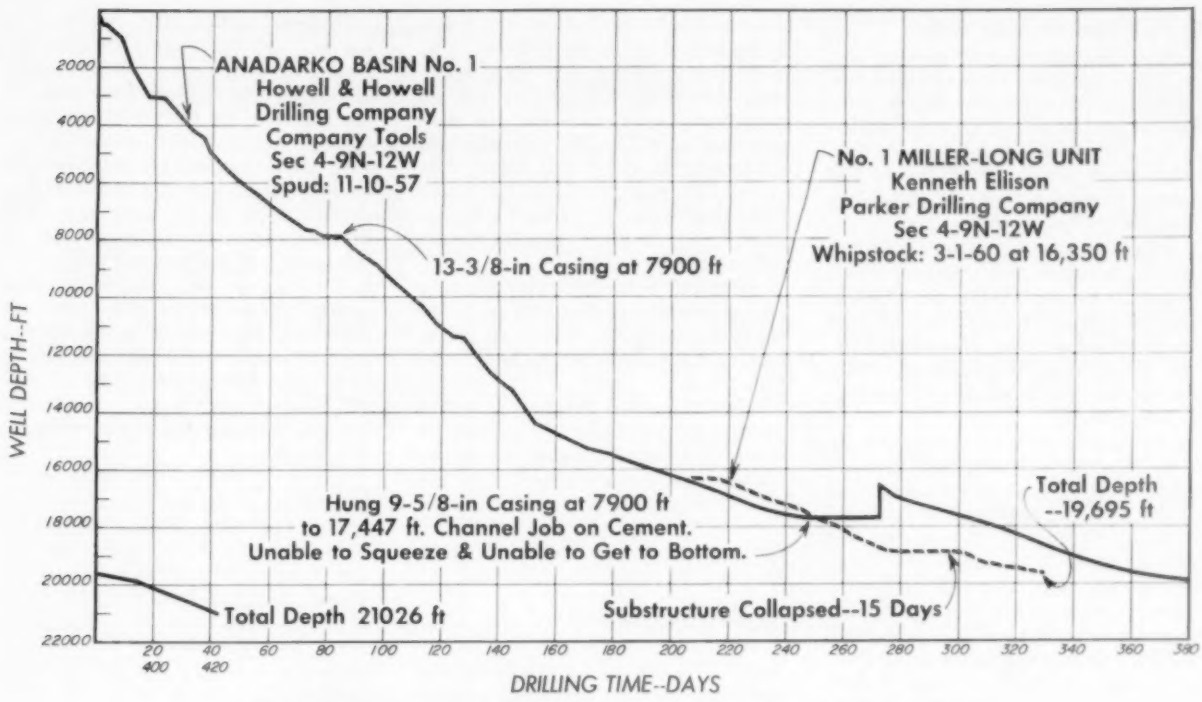


FIG. 4. Drilling progress chart compares the No. 1 Miller-Long Unit with the original Anadarko Basin No. 1 which was drilled to a total depth of 21,026 ft. Second hole was drilled to 19,695 ft before unsuccessful completion in the Bois d'Arc limestone.

through the rig floor with the pipe but was not seriously injured.

Nothing was dropped in the hole and all damage was to equipment above ground. The derrick was a loss but the foundation was not affected by the accident.

Two large cranes were used to pick the pipe out of the top of the buckled derrick, stand by stand. The damaged derrick was then removed and a new one was erected. In only seven days after the accident, a diamond bit was on its way back to the bottom of the hole.

The trip back into the hole was a careful and time-consuming operation. Stands of pipe were picked up and pins and boxes were checked before being added to the string. Mud was circulated periodically to condition the hole and a few bridges were drilled through. On May 24, the bit touched bottom at 18,945 ft and began drilling ahead.

On June 17, a drilling rate change at 19,522 ft indicated the top of the porous and permeable Hunton (Bois d'Arc) limestone, the objective formation of this drilling program. On June 22, the hole reached 19,695 ft.

Liner Run and Cemented

On the first attempt to run a 4½-in. liner, the shoe plugged at a depth of about 10,000 ft. The liner was pulled and a bit was run back to bottom to condition the mud and the hole. After several other unsuccessful attempts, the liner was finally run and cemented on July 3.

The 4½-in. liner consisted of 111 joints of 14.98 lb per ft, P-110 (4718.22 ft) and 147 joints of 13.5 lb per ft, N-80 (5090.34 ft), a total of 9808.56 ft of length. It was cemented with 330 sacks of slow-setting cement with silica flour and a retarder. A temperature survey indicated the top of the cement at 13,900 ft. Washed down with tubing and found the top of the landing collar at 19,490 ft.

A gamma ray-neutron log was then run and located the top of the Bois d'Arc limestone at 19,491 ft and the bottom of the 4½-in. liner at 19,516 ft. Top of the 4½-in. liner was found at 9696 ft and the top of the 7-in. liner at 9671 ft.

A series of drillstem tests in the 7-in. liner and in the 9⅝-in. casing confirmed the suspicion that gas which had been entering the hole was coming from behind the 4½-in. liner. In order to expose all of the Bois d'Arc limestone for acid treatment, the liner was perforated with 5 jets per ft from 19,491 to 19,516 ft.

The first acid treatment consisted of 30 bbl of acid. Swabbing recovered 2 to 2½ bbl of fluid per hour with little gas. After another acid treatment with 5000 gal of acid, the well was swabbed to 7500 ft and 2 to 3 bbl per hour of acid and salt water were recovered.

A 30-sack cement plug was then spotted near the bottom of the 4½-in. liner to plug off the Bois d'Arc limestone. When the pipe was pulled, holes were found in the tubing just below the packer, indicating that the acid had eaten the holes in the pipe and that the acid had been displaced primarily in the annulus.

In fact, the operator is of the opinion that, with the hydrostatic pressure and 300 F temperatures at 19,500 ft, the attempted acid treatments were practically ineffective. It is believed that very little, if any, acid actually reached the Bois d'Arc limestone.

A tungsten carbide mill run into the hole found spots of spongy cement at intervals from 11,400 to below 16,000 ft. The mill went to bottom cleaning out cement, acid, and gelled mud.

In an effort to remove and recover that portion of the 4½-in. liner above the cement, a jet cutter was run to 13,025 ft and fired. However, a spear run into the top of the liner could not jar the pipe segment free.

Another 5000-gal acid job was performed by closing the rams on the annulus after a packer run to 16,250 ft would not hold. While swabbing to 5000 ft, the well began to flow mud, gas, and water. Gas flow increased to a level estimated at 750 to 1000 Mcfd on a 14/64-in. choke with flow pressure at 900 psi and rising.

Completion in Bois d'Arc

After this encouraging flow of gas, the pipe was pulled from the hole and tubing was run in for completion. Tubing extended to 19,532 ft and consisted of 6900 ft of 2⅜-in., J-55 on bottom, 3000 ft of 2⅜-in., N-80 up to the packer at 9632 ft, and 2⅞-in., P-105 from the packer to the surface.

After the packer was set and tested and a Christmas tree installed, swabbing was resumed. While swabbing at 5200 ft, gas started breaking through the fluid and the fluid level started rising. The decision was made to release the rig and then allow the well to flow to clean itself.

On August 8, the rig and derrick were completely moved out. Pressure on the tubing, after having been shut in for 50 hours, had risen to 2350 psi. Casing pressure was 450 psi but was bled down to 50 psi before the tubing was opened. On a 24/64-in. choke, the tubing flowed gas for four minutes before pressure dropped to 1500 psi and the well began unloading mud, acid, and water. After 25 minutes of flow, the pressure had dropped to 750 psi and the choke was changed to 12/64 in. After 3 hours, the well was shut in with pressure at 100 psi.

The following morning, after the well had been shut in for 11 hr, tubing pressure was 1450 psi. Well flowed fluid and some gas and pressure dropped to 1000 psi before being shut in at around 7:00 p.m. After several days of "rocking" the well by overnight shut-in and flowing on choke during the day, several "suds sticks" were dropped down the well in an attempt to help the well unload water. The well continued to produce sudsy water and gas as the daily shut-in pressure gradually declined.

It was decided to pull the packer which was set at 9632 ft in the 9⅝-in. casing and set a packer in the 4½-in. liner as near the top of the Bois d'Arc limestone as possible. This would separate the Bois d'Arc from the Springer sands up-hole and allow the limestone to be tested separately.

A workover rig was moved in and rigged up on October 16. While trying to unseat the packer, the tubing parted at 7264 ft. Fishing with an overshot failed to recover the packer and parted tubing. After a freepoint indicator determined that the stuck point was at the packer, a stringshot was fired at the packer and then a hole was perforated in the tubing just below the packer in efforts to release the packer. These attempts were unsuccessful and a washover shoe was run with 12 ft of washover pipe. The packer and all tubing were finally removed from the hole on October 31.

An interesting and significant occurrence was that the bottom few joints of the pulled tubing were found to be completely plugged with dehydrated mud. The mud dehydration was apparently caused by the heat and pressure with depth. Engineers on the well were understandably and deeply concerned that mud invasion of the deeper formations followed by such dehydration would result in blockages very difficult to overcome.

After the hole was conditioned, a packer was set on wire line at 16,358 ft. Tubing was run with a stinger to seat in the packer before testing the Bois d'Arc.

Tests of the Bois d'Arc continued by swabbing until November 16. Quantities of gas were produced throughout the tests, but indications of commercial quantities of gas were never established. Finally, the well was secured and the rig was removed. The well is now classified as "temporarily abandoned."

What's To Come?

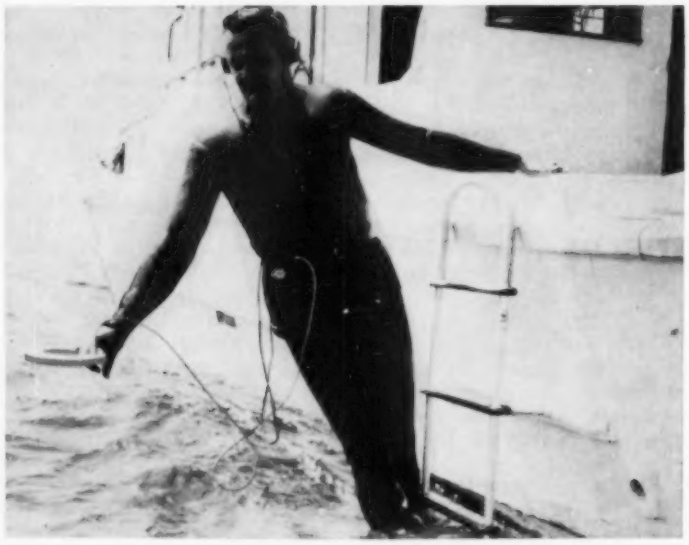
What's next for the No. 1 Miller-Long Unit? Why has this $4 million hole been merely "temporarily abandoned?"

Owners and operators of this well are not yet fully ready to give up. Enticing gas flows encountered throughout the drilling of the well are one incentive for further efforts. And, as one interested party observes, "we have not yet reached the objective that we established when the well was first spudded over three years ago — the Bromide sand. The geological anomaly that prompted drilling the well in the first place has not changed. In fact, a recent seismic review of the area confirms the presence of a deep-seated faulted anticline. Perhaps the deeper Ordovician formations will be the payoff. New efforts to reach this target are now tentatively scheduled to begin this month.

However, one of the most astute evaluations of the situation came from an observer who noted that, "some folks might think that going back in that hole would just be sending good money after bad, but there's been lots of oil and gas found that way. It's a good thing that this business has got men in it who have the guts to 'try it again' — they're the ones who have made the oil business." * * *

Detecting underwater pipelines

Inductance coil of audio detector is held over side of surface vessel to detect underwater pipe lines extending 4500 ft off the California coast near Ventura. Details of the pipe detecting operation were described on page B-48 of the January 1961 issue. The original article was prepared by Tinker and Rasor of San Gabriel, California, who supplied the Pearson-type detection equipment used in this unique underwater pipeline survey.



Deep in the Delta County . . .

JOHN W. MECOM PREPARES FOR A 26,000-FT WELL

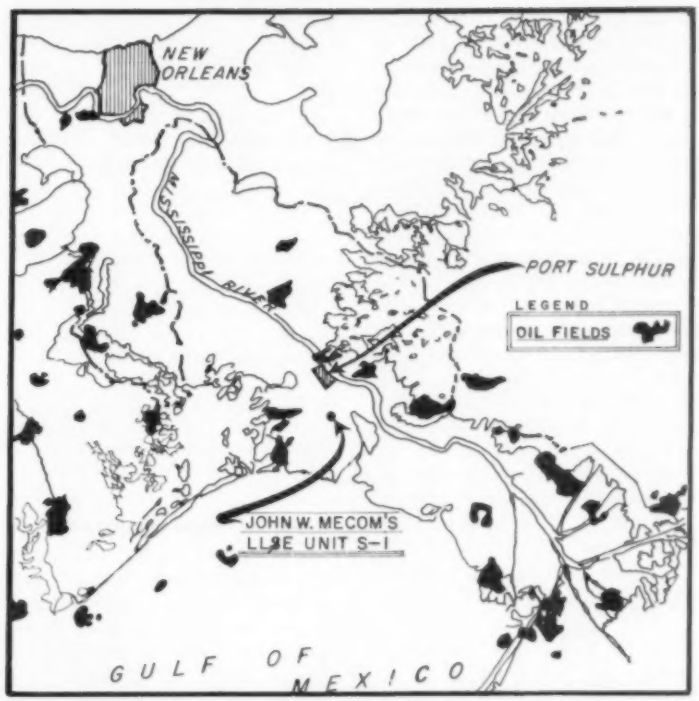
J. E. KASTROP
The Petroleum Engineer, Dallas, Texas

A giant steam barge rig and a seasoned crew are already past the 13,000-ft mark in the search for deep oil that may take them to 26,000 ft and a new world's record

DOWN IN THE LOUISIANA delta swamp country of the Mississippi River where deep wells are nothing spectacular, John W. Mecom, Houston independent oil operator, has set his sights on finding oil . . . not setting records . . . although he is prepared to set one if that's what it takes. The well's designation is Mecom's LL&E Unit S-1 (for Louisiana Land & Exploration Company of New Orleans) located about 4 miles south of Port Sulphur (on the west bank of the Mississippi) and 45 miles southwest of New Orleans. It is situated on the heart of the ultra-deep drilling country where world's depth records are not new. In 1955 and early 1956, Richardson & Bass of Ft. Worth, Texas, as operators, established a world's depth record in its No. 1-L Humble LL&E State 2414, a joint venture of Richardson & Bass (Louisiana Account), Freeport Sulphur Company and John W. Mecom. The Humble LL&E No. 1-L went to 22,570 ft and found oil and gas around 22,000 ft and above, but later was temporarily plugged due to completion difficulties.

The new well is in deep producing territory and is located not quite a mile west of Mecom's Price Unit P-1 where oil comes from below 19,000 ft.

The deepest well ever drilled in the world to date was Phillips Petroleum Company's University EE-1, located in Pecos County of West Texas. Total depth was 25,340 ft, but the well was not a commercial producer.



Deep drilling's back yard and location of John W. Mecom's LL&E Unit S-1 . . . right in the big middle of that back yard. Well is 8000 ft east of 1955 world's record well (T.D. 22,570 ft) and less than a mile west of ultra-deep oil production.

Drilling Equipment

To drill his deep test, Mecom is using a heavy duty steam barge rig formerly Richardson & Bass' Rig 25 which drilled the world's deepest record well in December 1955 (see *The Petroleum Engineer*, December 1955, pg. B-35). In fact, the tool pusher and many of the crew who worked on the 1955 depth record well are still running the rig now drilling below 13,000 ft on Mecom's LL&E Unit S-1. It was originally placed in operation in 1947 and has established an enviable record since for deep drilling, primarily in the Lake Washington area where it is now working. Modifications have been made as new equipment and techniques have been introduced. The rig utilizes two barges, one mounting the boilers and generators, and the other housing the rig and mud handling equipment.

The boiler barge is equipped with five 125-hp fire tube boilers and condensers to reduce fresh water requirements, since fresh water must be barged to the location. The rig is equipped with a standard type derrick capable of standing drill pipe in threbles. Steel rotary hose is used. Individual steam drives are used on all major components of the rig.

The drawworks is driven by a 16-in. by 16-in. steam engine. A vertical steam engine is used to drive the rotary table. Steam driven pumps include two 22-in. duplex and one 20-in. triplex . . . the latter is used for mud mixing and conditioning purposes. The duplex steam powered pumps are used exclusively for circulating. In addition to mud guns, two propeller type mixing units are employed to condition the mud. The mud system also includes a degasser and a centrifugal desander.

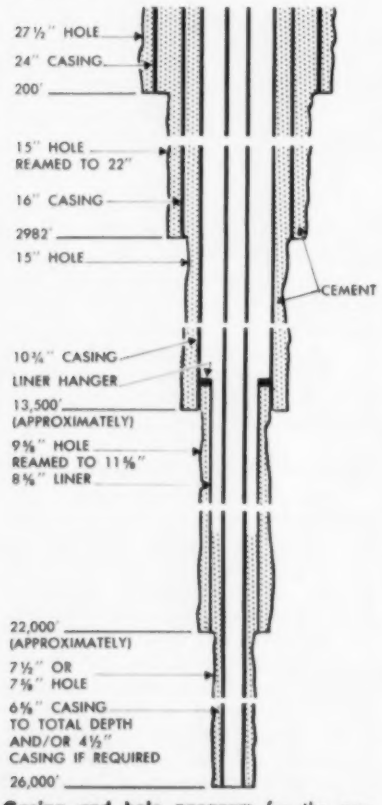
Planned Drilling Program

Drilling has proceeded according to plan thus far, (below 13,000 ft at this writing). It is expected that prior to reaching 13,700 ft, 10¾-in. casing will be set . . . probably around 13,500 ft. The well was spudded in mid-December 1960 with a 27½-in. bit, and 24-in. conductor pipe set to 200 ft and cemented to surface. The 15-in. hole will be drilled to a depth between 13,000 and 13,700 ft to a good casing point and 10¾-in. casing will be set and cemented all way back to the surface.

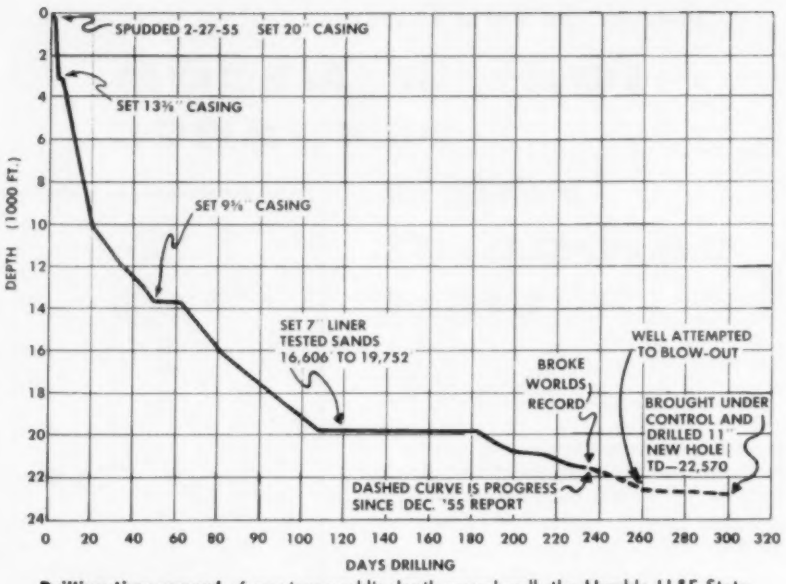
Below the 10¾-in. casing, a 9⅝-in. hole will be drilled to around 22,000 ft where an 8⅝-in. liner will be run and cemented. However, should

good production possibilities exist in this interval or at any point below, testing will be initiated and if production is found adequate, the well may be completed.

Although there are several interesting sands that might be potentially productive at a number of points below 13,700 ft, the entire drilling and casing program has been designed to carry the well to 26,000 ft if necessary. Beyond the 22,000-ft point, hole size will be either 7½ or 7⅞-in. in order to provide the operators with some flexibility as to hole and casing size down to bottom should any unforeseen difficulty develop. For example, a 6⅝-in. casing could be set to total depth and brought all the way to the surface, or hung inside the 8⅝-in. liner. Or, if it is necessary to set the 6⅝-in. casing before reaching the total depth, the well could be drilled deeper and 4½-in. casing run to bottom, hung inside the 6⅝-in. or run to surface. The entire hole and casing program is a significant factor in the success of the well... regardless of whether or not production is found at some higher interval than expected... or if trouble is encountered... or, if the well proceeds smoothly all the way to the projected 26,000 ft.



Casing and hole program for the new Mecom well is a significant part of the project. It will enable unusual flexibility... especially below 22,000 ft... to handle several potential drilling and completion conditions.



Drilling time record of previous world's depth record well, the Humble LL&E State 2414 No. 1, drilled in 1955 as a joint venture by Richardson & Bass (Louisiana Account), Freeport Sulphur Company and John W. Mecom. It is hoped the new well will reach total depth in about 260 days.

Planned Mud Program

For most of the way down, the drilling fluid program is basically the same program already proven in this area. From the surface to 3000 ft, a native mud was used, consisting of water, drilled clays, and bentonite. It was treated with caustic and quebracho to maintain desired viscosity and to insure a gage hole. Weight was increased to 9.5 and 9.8 lb/gal down to around 9000 ft when the system was converted to gyp mud. This conversion was made by adding gypsum, ferrochrome lignosulfonate and caustic soda. From 9000 ft to about 11,000 ft, the weight was increased to 10.5 lb/gal and the water loss maintained around 8 cc. Near 12,300 ft, the mud weight was increased to approximately 12.5 lb/gal and the water loss dropped to around 6 cc. As an aid in the control of filtration and flow properties of the mud, a water-soluable surfactant (an oxyethylated phenol) was added, thereby making a gypsum surfactant mud system.

After drilling out from the 10¾-in. protector string, soda will be used to control the pH due to cement contamination. Centrifuges will be used to maintain the specific gravity of the mud, which will be increased to about 18 lb/gal. Water loss will be dropped to 3 or 4 cc and viscosity maintained at about 60 sec.

Drilling will continue with this type mud system until an increase in temperature is noted. When temperature does effect good mud maintenance, the system will be converted to a sodium surfactant mud. The conversion is made by replacing the calcium ion with soda ash. Ferrochrome lignosulfonate will be used to control the filtrate rate.

With this high temperature mud, the well will be drilled to bottom. This type of mud is similar to the mud system used successfully by Hunt Oil Company in its J. O. Walker No. 1 drilled to 20,603 ft near Laredo, Texas in the spring of 1960. Bottom hole temperatures in the Texas well were recorded at 456F (see *The Petroleum Engineer*, May 1960, pg B-19).

What About Costs?

If experience in drilling the former world's deepest well back in 1955 is any guide, (it went to 22,570 ft), Mecom's LL&E Unit S-1 should be in the neighborhood of $2 million. (The 1955 record cost at least this amount.) Since the location is between two ultra-deep and prolific areas (Lake Washington about 7 miles to the west, and Mecom's Price Unit P-1 well slightly over a mile to the east), prospects are good. The LL&E No. 1-L which reached a total depth of 22,570 ft, tested several zones which showed oil and water. It was first completed at 21,443-21,465 ft and later recompleted at 20,741-20,745 ft from which depth it produced for nearly two years before going to salt water and temporary abandonment. Should reserves be found at comparable depths or below in the new Mecom LL&E Unit S-1 well, operators are hopeful that the Louisiana Conservation Commission will consider altering its present depth bracket formula for establishing allowables in such ultra deep and ultra expensive wells. ★ ★ ★

In heaving-shale country an . . .

ULTRA-DEEP FISHING JOB

WALTER A. HOGAN
Field Editor

Overcoming problems presented by high temperatures, heaving formations, and long round-trips, Penrod Drilling Company recovers a drill pipe which stuck at 19,383 ft while being pulled after reaching a total depth of 20,077

AFTER REACHING A total depth of 20,077 ft in the heaving shale country of St. Mary's parish in Louisiana without difficulty, Penrod Drilling Company crews began pulling out of the hole. The drill string stuck at 19,373 ft, and thus began 42 days of fishing operations under supervision of Penrod's J. C. Craft, superintendent; Gus E. Howell, assistant superintendent; Dan H. Agee, toolpusher; and W. A. Poindexter, toolpusher. The Dallas contractor's Rig 17 crews performed the often tedious job of freeing the drill pipe fish and bringing it out of the hole.

Drill Pipe Stuck

While drilling at 20,077 ft, crew made a short trip. Upon returning to bottom, while drilling ahead complete returns were lost. Crew pulled seven stands and one single drill pipe, filling the casing with water as drill pipe was withdrawn, before the drill pipe stuck at 19,373 ft (No. 1).

Casing had been filled with 125 bbl of water when the well began kicking and the crew closed the blowout preventers as a precaution. Pressure was bled off the casing, blowout preventers opened, and the casing filled with water.

Crew pumped in 125 bbl of 17.8-lb mud into the drill pipe, raising the pressure to 2150 lb. Then 35 bbl of mud was drained off the drill pipe to reduce pressure.

During this time, a total of 349 bbl of water was pumped into the annulus in an attempt to keep it full, but the level continued to drop.

An attempt was made to pump into the formation, but this failed. The top of the drill pipe was then frozen with dry ice and the kelley with one joint of drill pipe were laid aside, since pressure could not be bled off drill pipe.

Fishing Preparations

A safety valve and a lubricator were installed on drill pipe.

Mud pressure applied to the drill pipe failed to pump into the formation.

A retrievable drill pipe plug and

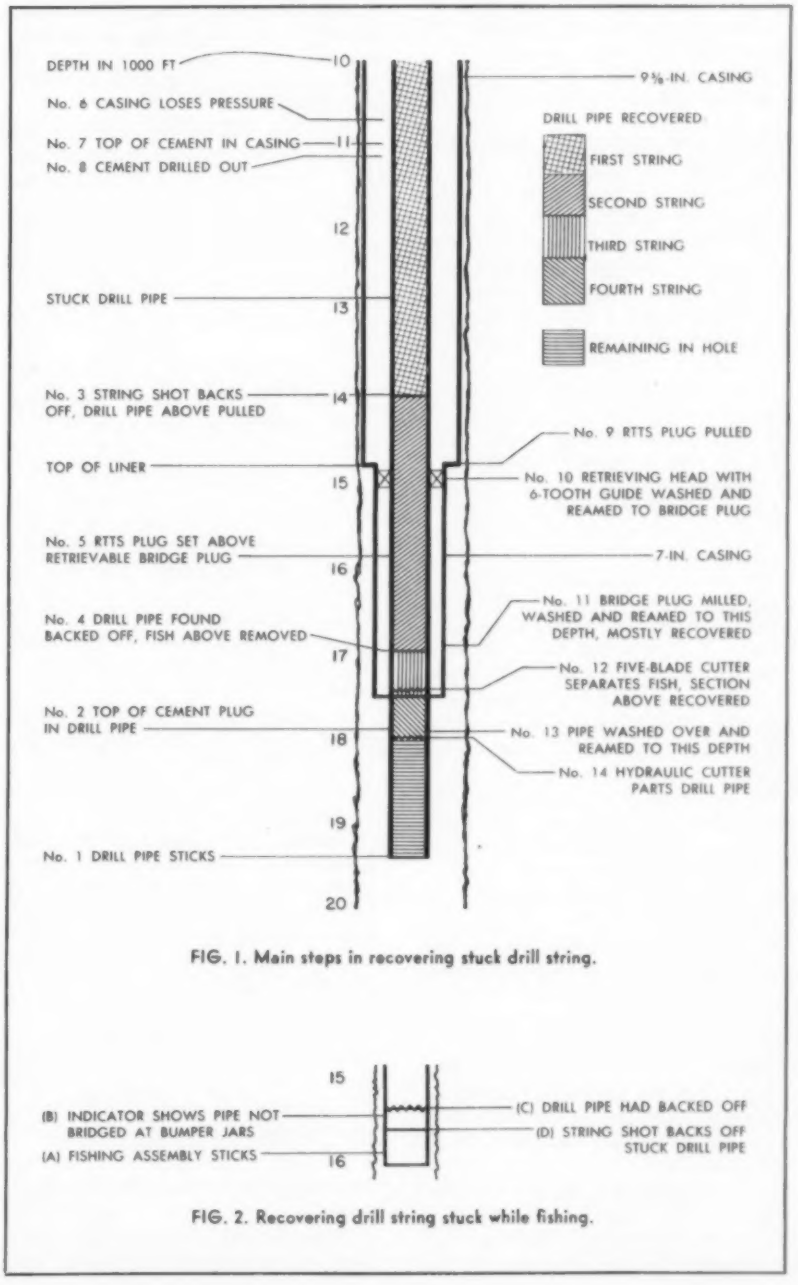

DEPTH IN 1000 FT
10
No. 6 CASING LOSES PRESSURE
No. 7 TOP OF CEMENT IN CASING
11
No. 8 CEMENT DRILLED OUT
12
STUCK DRILL PIPE
13
No. 3 STRING SHOT BACKS OFF, DRILL PIPE ABOVE PULLED
14
TOP OF LINER
15
No. 5 RTTS PLUG SET ABOVE RETRIEVABLE BRIDGE PLUG
16
No. 4 DRILL PIPE FOUND BACKED OFF, FISH ABOVE REMOVED
17
No. 2 TOP OF CEMENT PLUG IN DRILL PIPE
18
19
No. 1 DRILL PIPE STICKS
20
9⅝-IN. CASING
DRILL PIPE RECOVERED
FIRST STRING
SECOND STRING
THIRD STRING
FOURTH STRING
REMAINING IN HOLE
No. 9 RTTS PLUG PULLED
No. 10 RETRIEVING HEAD WITH 6-TOOTH GUIDE WASHED AND REAMED TO BRIDGE PLUG
7-IN. CASING
No. 11 BRIDGE PLUG MILLED, WASHED AND REAMED TO THIS DEPTH, MOSTLY RECOVERED
No. 12 FIVE-BLADE CUTTER SEPARATES FISH, SECTION ABOVE RECOVERED
No. 13 PIPE WASHED OVER AND REAMED TO THIS DEPTH
No. 14 HYDRAULIC CUTTER PARTS DRILL PIPE

FIG. 1. Main steps in recovering stuck drill string.

15
(B) INDICATOR SHOWS PIPE NOT BRIDGED AT BUMPER JARS
(A) FISHING ASSEMBLY STICKS
16
(C) DRILL PIPE HAD BACKED OFF
(D) STRING SHOT BACKS OFF STUCK DRILL PIPE

FIG. 2. Recovering drill string stuck while fishing.

landing nipple combination was lowered to 17,987 ft but would not go any deeper. Efforts at pumping in and bleeding off drill pipe to get the plug lower yielded no results and so the plug was pulled out. Wire line unit and lubricator were rigged down.

Cement Plug Set

A slurry prepared from 400 sacks of 22.5 lb barite was displaced into the drill pipe with 230 bbl of 17.8 lb mud. After allowing plug to set for eight hours, pressure was applied, but it bled off.

Then 200 sacks of slow-setting cement with retarder were displaced into drill pipe with 232 bbl of 17.8 lb mud. A squeeze was obtained with the cement, as the final pressure of 4500 lb did not bleed off.

Pressure was bled off the drill pipe, and there was no back flow.

Free Point Indicator, Back-Off Tool Run

A free point indicator was run in the drill pipe to 17,929 ft (No. 2) where it reached the top of the cement plug and showed that the pipe was free at that point. Indicator was pulled out of the hole, and a collar locator and string shot were run in an attempt to back off the pipe at 17,827 ft.

Four other string shots were run in the hole successively but failed back off the pipe. Some failed to fire, probably due to extreme temperatures at this depth.

String shot five would not get below 15,950 ft and was pulled from the hole.

A core barrel with assembly was run and the top of the junk, probably caps off the shots, was found at 15,722 ft. Core barrel assembly was spudded to 15,864 ft, then pulled out of the hole without making a recovery of the junk.

String shot six failed to fire and it was pulled out of the pipe, but string shot seven succeeded in backing off the drill pipe at 13,954 ft (No. 3).

While pulling drill string above the back-off point, pressure on casing went from 2100 lb to 2700 lb, making it necessary to pump 3000 bbl mud through the drill pipe in attempt to get mud circulated.

Crew opened blowout preventers, and circulated to raise weight of returns to 15.2 lb.

Crew screwed back into the fish and ran a spear on a wire line but were unable to get below 13,954 ft. Then they pulled the assembly, backing off with the rotary. Since they were unable to establish circulation, they pulled out of the hole.

It was found that the drill pipe had backed off at 16,923 ft and 97 joints of 3½-in. mud-plugged drill pipe were recovered. Mud was removed by running eight stands in the hole at a time and pumping it out (No. 4).

Casing Tested

A 6-in. bit with sub was run into the hole to the top of the fish at 16,923 ft and circulation maintained for six hours. Returns were gas cut, but later stabilized.

Drill pipe was pulled and a 7-in. OD retrievable bridge plug with a RRTS tool was made up and run into the hole, but it would not go below 13,064 ft. Crew pulled pipe out of the hole and laid down the tubing with its assembly.

An 8⅝-in. OD casing roller with assembly was picked up and run in the hole but was obstructed at 5066 ft. After rolling the casing at this depth for 1½ hours without making any hole, assembly was pulled out. All but one roller in tool had frozen during rolling operation.

Then an 8⅜-in. OD casing roller with assembly replaced the larger tool and was run in the hole to roll the casing from 5066 to 5068 ft. It came free and was run to 13,036 and rolled to 13,064 in three hours without trouble. It took three hours to roll two more ft to 13,066 before tool was free for lowering to the top of liner at 14,794 ft.

After circulating and conditioning mud for 2½ hours, crew pulled drill string and went into the casing with the retrievable bridge plug and RTTS tool.

Crew set the bridge plug at 14,820 ft. RTTS tool was set four feet above the packer (No. 5) and pressure was built up below the tool. Casing held pressure at this depth, and with six subsequent settings up to 11,177 ft. When tool was set at 10,634 ft (No. 6) and four bbl of water were pumped into the drill pipe, it lost pressure completely.

A service unit pumped 20 bbl of diesel oil into the drill pipe, then 300 sacks of cement mixed with diesel oil were pumped in to raise pressure, then finally to effect a squeeze.

Testing tools were pulled up 120 ft, packer was set and 1000 psi of pressure applied to the casing for a satisfactory test. After waiting on cement to harden for two hours, it was found that well would not flow, and tools were pulled out of the hole.

A rotary bit and assembly were run in the hole, and used to wash from 10,628 to 11,072 ft, then to drill cement from 11,072 to 11,112 ft. After circulating for 2½ hr at this depth, assembly was lowered to top of liner at 14,794 ft and circulation was conducted before it was pulled out of the hole.

The retrievable hanger and testing assembly was picked up and run in to 10,604 ft. During a pressure test, casing broke down and went on vacuum.

Leak in Casing Squeezed

While pumping slow-setting cement in a slurry, pressure in the drill pipe rose, then drill pipe went on vacuum.

After cement was in place 3 hours it held a pressure of 1400 psi.

Drilling crew reversed out and pulled pipe up two stands to 10,584 ft and set the packer. Cement was allowed to set for four hours under pressure, then this pressure was released and the tool was pulled out of the hole.

An 8⅜-in. OD bit assembly was lowered and reached the top of the cement at 10,993 ft (No. 7) and drilled to 11,094 ft (No. 8).

Drill string was lowered to top of liner and mud was circulated three hours, then the crew pulled the drill string out of the hole.

Retrievable hanger and RTTS tool assembly was picked up and run into the casing. RTTS tool was set at 10,604 ft, pressure was built up below through the drill pipe and it held. Pressure applied on the casing above the packer also held.

A trip was made with an RTTS tool to recover the retrievable bridge plug where it had been set at 14,820 ft. However, the RTTS tool failed to get into the top of the liner at 14,794 ft. Crew pulled this assembly out of the hole (No. 9), laid it on the derrick floor, picked up and ran a retrieving head with a 6-tooth guide on the bottom. With this tool they washed and reamed cement from top of the liner at 14,794 ft to the top of the retrievable bridge plug at 14,820 ft (No. 10).

Fishing for Bridge Plug

They pushed the bridge plug down the hole to 14,850 ft and recovered a piece of its fishing head 2-in. OD by 17-in. long. This left 16-in. of a 1-in. rod with a jam nut projecting above the plug.

There was also a 5½-in. OD six-tooth washover head left in the hole.

A bottom-hole assembly consisting of a 3-⅛-in. OD overshot with a 1-in. grapple, a 4 15/16-in. OD mill guide, and assembly were run.

Crew ran this assembly down the casing to the top of the bridge plug fish, and then milled the nut off the 1-in. pin on top of the bridge plug. Then they pushed the fish down the hole to 14,870 ft while attempting to tie onto it.

Assembly was pulled out of the casing without making any recovery. The bridge plug's mandrel had gone through the control head and bumped up against the bottom of grapple a total of 6¼-in.

Crew picked up a 4⅛-in. OD short

catch overshot with a 1-in. grapple located 3½-in. above the bottom of the overshot plug assembly and ran them into casing to top of the fish at 14,870 ft.

Fish was engaged and 1½ hr spent trying to get over the top of the fish, but it was pushed down the hole to 14,899 ft.

When drill string and assembly was pulled out, no recovery had been made. Fishing tool had not gone over the 1-in. OD rod on the bridge plug so it was removed from the drill string.

A 5 11/16-in. OD jet basket with six-tooth rotary shoe and two 5½-in. OD boot baskets were run on the drill string to 14,893 ft. After circulating for 1¼ hours, a steel ball was pumped down into the head and tool jetted and rotated on top of the fish for two hours.

Then the fish was pushed down to 14,931 ft with weight from O to 15,000 lb.

When basket was removed from the casing, three teeth from the washover head, several pieces of junk and cement were recovered.

Next step was to go back into the casing with a short catch overshot and other assembly.

After trying to tie-in to the fish, it was pushed down from 14,932 ft to 15,035 ft. Drill string and fishing assembly were pulled out without making a recovery.

A five-tooth 5¾-in. OD tungsten carbide rotary shoe with assembly was made up and run into the casing.

Tools got over the bridge plug fish at 15,035 and pushed the fish to 15,053 ft using 20,000 lb of weight.

Then the crew started milling with 2000 to 6000 lb weight to reach 15,074 ft. After milling for 12 hours on the bridge plug, the rotary shoe was finally pulled from the top of the fish at 15,075 ft.

Next, a four-tooth rotary shoe with assembly was run to wash the bridge plug from 15,075 to 15,552-ft, but it would not move down hole without rotating and circulating the assembly. It began to go downward with 16,000 lb weight with no torque applied and when it reached 15,582 ft it started moving with normal drag until it reached 16,915 ft. Then 13 hours were spent milling for an additional two feet to 16,917 ft before assembly was pulled out of the casing. About 3½ lb of junk was removed from the boot basket.

Shoe and boot basket run. Another assembly consisting of an 8-tooth rotary shoe and boot basket with assembly was run.

Crewmen milled on bridge plug at 16,918-ft and succeeded in washing it about 8-in. before losing all torque on the drill pipe.

After pulling the fishing assembly from the casing, the top expander core off the bridge plug, about 11 in. was found fouled in the bottom of the shoe and recovered.

Jet basket and boot basket run. An assembly was run using a jet basket and boot basket to rotate and jet for 2½ hours, resulting in the recovery of ⅓ of top valve cage when assembly was pulled and removed.

Next run used a four-tooth rotary shoe and a boot basket with assembly.

It took 14 hours of milling on the bridge plug to make one ft, and when assembly was pulled out of the casing, about four lb of junk was recovered from the boot basket. The milling had dulled the rotary shoe.

Next assembly used a six-tooth tungsten carbide rotary shoe and a boot basket.

After milling six hr on the bridge plug at 16,919 ft without making any progress, the assembly was pulled out of the casing. Most of the bridge plug was recovered (No. 11), however 22-in. of 1-in. rod and drag springs remained in hole.

More Stuck Pipe Recovered

Circulating, jetting, washing. Crew went into the casing with an assembly using a jet basket and boot basket with assembly. Circulating and jetting for three hours yielded about 1½ lb of junk. Crew then picked up a 5⅞-in. OD scalloped shoe, 19 joints of 5-in. OD extreme-line wash pipe in a 575.25 ft section, with assembly including twelve 4⅛-in. OD drill collars. Assembly was run in and over the drill pipe fish to wash over 20 ft.

This assembly was picked up and a connection made to wash over the fish from 16,918 ft to 17,483 ft. Crew circulated for one hour and pulled out of the casing.

Drill pipe cut. Then the crew picked up a 5½-in. OD five-blade cutter, 19 joints of wash pipe, and other assembly including twelve 4⅛-in. OD drill collars.

This assembly was run in the hole to cut the 3½-in. OD drill pipe at 17,443 ft (No. 12).

Then crew recovered 17 joints and one cut piece of the stuck 3½-in. OD drill pipe totalling 523.76 ft.

Burning shoes used. A 5⅜-in. OD rotary shoe with other assembly was run in the hole and washed to 17,505 ft. Then assembly was pulled up to 17,445 ft and circulation conducted before it was pulled from the hole.

An eight-tooth rotary shoe with assembly was run into the liner.

After reaming from 17,470 ft to 17,505, fish was washed over to 17,582 ft. Assembly was pulled for a new shoe.

Washing and reaming with another shoe brought assembly down to 17,604 ft.

A four-tooth, 5¾-in. OD scalloped rotary shoe with assembly was run and washed over fish to 17,687 ft.

For 10 minutes mud was gas-cut. Assembly was pulled up into the liner, then circulated out as it was pulled for a new shoe.

An eight-tooth rotary shoe was run with assembly and seven hours were spent washing over from 17,687 ft to 17,709 ft. Rotary torqued up, then lost all torque and assembly was pulled out of the casing. A hydraulic jar had twisted in two.

A four-tooth scalloped shoe with the same bottomhole assembly with one set of hydraulic jar was run into the casing.

This assembly washed from 17,709 ft to 17,901 ft although the hole was heaving.

Washing and reaming ended at this depth (No. 13).

Circulating operations were conducted to combat heaving hole and gas-cut mud. Then string was pulled up into casing and circulated out.

Hydraulic Cutter Used

Preparing to cut the stuck drill string fish, a 5½-in. OD hydraulic cutter with assembly was picked up and run in the hole. It cut the stuck drill string at 17,945 ft (No. 14), permitting the crew to pull and lay down 15 joints and two cut pieces of 3½-in. OD drill pipe totaling 503.75 ft.

Crew went back into the hole with a 6-in. OD bit, and assembly.

Heaving formations. With this assembly crew washed from 17,483 ft to 17,945 ft then since mud was gas cut, they circulated and conditioned for six hours.

Crew pulled out of the casing and picked up another four-tooth rotary shoe with assembly.

While using this assembly, after washing from 17,965 to 18,032 ft, the hole heaved and stuck the pipe. It was worked free in one hour and 3½ hr were spent circulating and building weight of gas-cut mud.

Crew resumed washing and had washed to 18,035 ft when the hole heaved. After 1¾ hours the pipe was worked free and the mud was circulated for 30 minutes, then pulled up in the casing and cuttings were circulated out. Assembly was pulled from hole.

A scalloped, four-tooth rotary shoe was used to wash and ream from 17,945 ft to 18,035 ft and then circu-

lation was conducted while six lb per bbl of additive was put in the mud to help prevent drill pipe from sticking.

After washing to 18,043 ft, the pipe stuck and was worked free in 35 minutes and then washed to 18,050 ft before it stuck again and was worked free in 15 minutes.

Drill pipe stuck at 18,129 ft and ¾ hr was spent working it free. Then it was run to 18,156 ft before it stuck again and 1¼ hr spent working it free.

Mud returns were loaded with shale and gas cut.

Washing resumed. An eight-toothed rotary shoe with assembly was run and stuck while washing at 18,160 ft. Assembly was worked free in 1¼ hours and washed to 18,208 ft before the pipe stuck. Mud was circulated and pipe came free and was pulled up in casing because returns showed gas-cutting.

Crew ran assembly back in, hit a bridge at 18,000 ft, washed the bridge out to 18,035 ft and returned to bottom. After circulating, the assembly was pulled up into the casing. After more circulating, assembly was lowered to bottom and an additional 1½ hours was spent circulating.

Crew had started pulling assembly out of the hole and 82 stands had been pulled when it became necessary to shut down because hole would not take mud. Crew went back in to 17,820 ft and closed blowout preventer. Pressure built up to 1600 psi on casing and 1500 psi on drill pipe in 10 min. Pressure started dropping, well went on vacuum, crew pulled up to 17,370 ft and the casing filled with water.

String Stuck During Fishing

When crew started pulling the fishing drill string out of the hole, it drug and finally stuck in the casing when it reached 15,914 ft (A). The drill pipe was filled with 80 bbl of mud and pressure applied, but there were no returns.

A free point indicator showed that the drill pipe was free at the bumper jars at 15,610 ft (B).

String backed off. Crew applied eight-and-four left hand torque and worked it down. Drill pipe backed off at 15,412 ft according to a collar locator (C).

Drill pipe was screwed back in at the back-off point. Then a string shot was run and fired to back off the drill pipe at 15,575 ft (D).

However, this permitted total recovery of 496 joints of drill pipe and 11 drill collars.

This left nine joints of wash pipe, a rotary shoe, safety joint, one set of bumper jars, and two sets of hydraulic jars, and one 4⅛-in. OD drill collar in the hole. These were allowed to remain in the hole.

Testing And Completing

Casing tested. An RTTS tool and casing test was run to test casing from 10,535 ft up, and it held pressure.

RTTS tool with casing test valve was run again, circulated at 10,535 ft, then was run in to 13,068 ft but would not go below that depth. It was set at 13,063 ft and used to circulate and condition mud. Well began kicking from differential pressure, blowout preventer was closed, pressure was bled off casing, then the preventer was opened and mud was circulated and conditioned.

Since RTTS tool drug and swabbed while being pulled from the hole, and 8⅜-in. OD casing roller was run in to work to the top of the liner.

Well completed as producer. Mud was circulated and conditioned in preparation for running a completion string of 7-in. casing.

Completion string was run, then perforations were made from 14,700 to 14,720 to bring in the well as a producer. * * *

Deepest well in Iran Hits depth of 14,865 ft

Iranian Oil Operating Company well has reached 14,157 ft, deepest ever drilled in that country. Well is Suru No. 1 near Bandar Abbas on the Straits of Oman, and it was drilled without undue difficulty until it stuck due to tight hole.

Casing program called for 20-in. to 791 ft; 13⅜-in. to 4685 ft; 9⅝-in. to 10,224 ft; and 7-in. to 12,582-in.

Mud program used from surface to 4685 ft was 75 lb per cu ft sea water from the Persian Gulf, salt water clay, and CMC mud. Then 84 lb per cu ft saturated salt water emulsion mud was used from 4685 to 10,224 ft.

From 10,224 ft to 14,865 ft, an 82 lb per cu ft to 96 lb per cu ft highly saline, 100,000 ppm salt) emulsion mud was used. Water loss was maintained below 2 cc with CMC.

Tight hole problems started at about 10,700 ft and continued intermittently to about 12,500 ft. It appeared that a highly fractured formation was sloughing in the hole, and increasing mud density seemed to help.

Before reaching projected depth of 15,200 ft, pipe stuck at 14,865 ft without any warning of tight hole trouble.

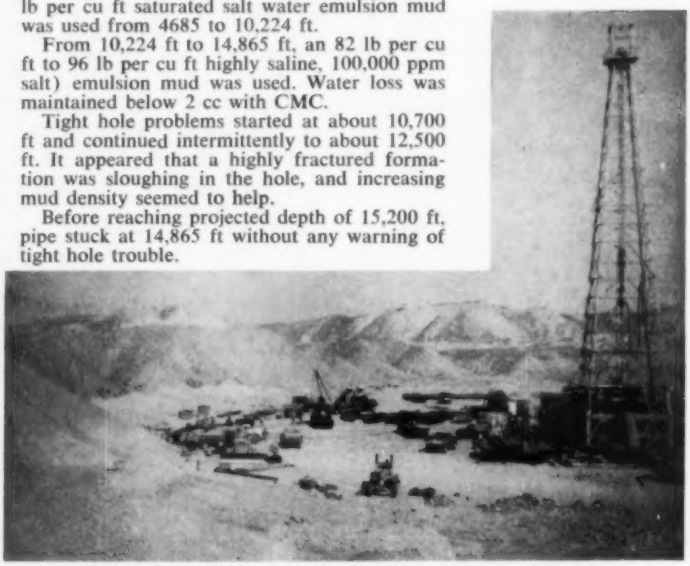


FIG. 1. Suru well No. 1 near Bandar Abbas on Straits of Oman.

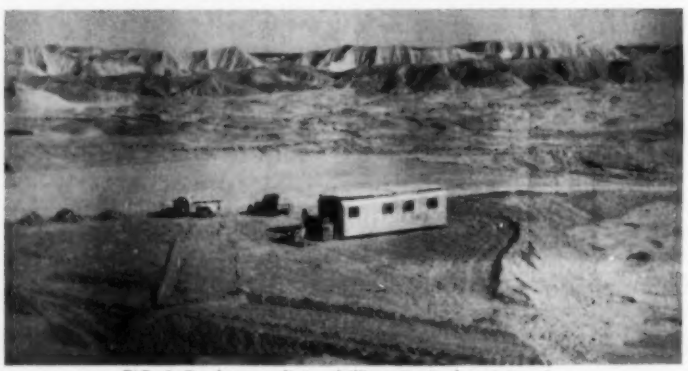


FIG. 2. Doghouse adjoins drilling site in desert terrain.

CHROMATES STABILIZE SHALE CONTROL MUDS AT HIGH TEMPERATURES

WALTER J. WEISS, JOHN S. BRUKNER and CLARENCE O. WALKER, *Research and Technical Department Texaco, Inc., Bellaire, Texas*

Anionic chromium compounds such as sodium chromate and sodium dichromate make shale control muds less sensitive to high temperatures. Additives prove successful to 350 F.

THE MODERN TREND is to deeper drilling in the search for more oil and gas. And, with this trend has come a serious problem: that of high temperatures. Another problem long associated with deep wells in certain areas is that of "heaving shale." The advent of shale control mud *(The Petroleum Engineer*, April 1958, pg. B-45) made it possible to penetrate these shale sections with far less probability of heaving or sloughing of the well bore. These inhibited systems have been restricted in areas having high well bore temperatures. The use of chromate as a stabilizing additive has extended the range of shale control mud which can now be applied in areas previously avoided because of higher temperatures. In laboratory tests and field applications, it has been found that (1) chromate is compatible with shale control muds and does not affect the well bore preservation reaction, (2) upon addition of chromate, flow properties are stabilized at high well-bore temperatures, (3) chemistry of shale control muds can be maintained without decreasing the benefits derived from the chromate, (4) chromate treatment of shale control muds can easily be performed under field conditions, (5) reduced mud maintenance requirements have been noted in field applications in areas of high temperature, and (6) the chromate development described here basically affects the rate of high temperature deterioration in drilling mud systems.

None of the weighted drilling mud systems in field use today . . . with the possible exception of the synthetic surfactant system . . . are immune to serious high temperature deterioration. Table 1 presents data on eight field mud samples subjected to high temperatures. These cover the four commonly used weighted mud systems, and show that at either extremely high or low mud weights, they all exhibit the same degree of high temperature reaction.

How Problem Was Approached

Since all weighted mud systems potentially possess the same high temperature sensitivity, research was directed toward high-temperature stabilizing Texaco's shale control mud system. This development would provide well bore stabilization and satisfactory high temperature performance. Although there are several approaches to stabilizing muds at high temperatures,[1,2] the importance of preserving the shale control character led to the development of anionic chromium compounds, e.g. sodium chromate and dichromate as temperature stabilizers for the shale control mud system.

Shale Control Mud

Since maintenance of well bore stability is one of the primary functions of a successful drilling mud, the clay chemistry and drilling fluid research sections of Texaco's Exploration and Production Research Division of the research and technical department conducted basic research on the substances found in these shale sections and their response to chemical modifications. This established two distinct mechanisms of shale disintegration: (1) a physical change in shape and volume arising from swelling by the imbibition of water, and (2) a spontaneous disintegration without change in volume which was designated by the term "self-dispersion."

Such self-dispersion of shale members in the well bore has been established as a major cause of the unstable well bore conditions known as "heaving shale" and led to the development of a shale controlling mud system[3,4] to alleviate this difficulty.

The shale control mud system couples a high filtrate calcium level with a controlled alkalinity environment to stabilize shale by progressive hardening. Such a shale control mud system is normally formulated entirely using calcium-containing materials such as calcium chloride, slaked lime, a satisfactory dispersant, and a suitable filtration control agent. The chemical and physical properties of a typical unweighted shale control mud are shown in Table 2.

High Temperature Mud Reactions

In the field application of drilling fluids, indication of a high temperature problem often is not readily identified. The same vicious cycle of daily mud maintenance is experienced as that which occurs when drilling "mud-making" formations. The "hot hole" condition results in an increased chemical requirement for maintaining good mud properties. Eventually, however, chemical treatment is insufficient for control of the physical properties and it becomes necessary to resort to water addition. Finally, a point is reached where even water fails to maintain satisfactory properties.

Usually the first definite indication of a serious high temperature problem is evident when attempting to run an electric log. Several attempts may be necessary before the tools can be run to bottom and a successful logging operation realized. Field indications of high temperature gelation can take other forms such as excessive pump pressures required to break circulation, abnormal resistance to running the drill pipe into the well, or a tendency for the mud chemistry to become and remain unbalanced so that the system resists equalization. It has been found that a relatively sensitive indication of high temperature deterioration can be obtained by maintaining a comparison between the viscosity of the mud going into the well from the pits and the mud returning from the flow line.

As a shale control mud begins to react to the effect of high temperature it has been noted that this viscosity differential will continue to widen.

Laboratory investigation substantiated field evidence that, in general, some degree of high temperature gelation occurs in most clay-water systems when exposed to temperatures above normal. It was further developed that high temperatures affect muds in two distinct ways. Under static conditions, temperature accelerates the development of gel structure in the mud. The end result of this gel development will depend upon the temperature, time for development, and susceptibility of the mud to gelation. Gel strength developed will range from a low, easily measured gel to a rigid cement-like mass which practically defies classification as a gel.

A second high-temperature reaction is the effect on viscosity. As with the gel development, temperature may have little or no effect on viscosity or may thicken the mud to a point where it becomes practically unpumpable. The end viscosity of a mud appears to be independent of whether the mud has been continually agitated or remained quiescent during the heating cycle.

For the above reasons we have chosen to classify the effect of temperature on the physical properties of muds into three characteristic patterns.

Normal Response to Temperature

Drilling mud slurries possess a property known as thixotropy. The clay particles of the slurry tend to orient themselves with time under a static condition to produce a semi-rigid gel structure. Elevated temperatures tend to accelerate the rate of formation and degree of development of this property to such an extent that muds often develop gel structures of appreciable strength.

Muds possessing a normal response to temperature will refluidize to a condition approximating their original viscosity when subjected to mechanical agitation.

Abnormal Response to Temperature

In a second response to temperature, which we call high temperature gelation, muds undergo gelation to yield similar semi-rigid structures. However, these gels are not thixotropic. They will not refluidize satisfactorily but remain as highly viscous to semi-plastic slurries.

The degree of gelation cannot of itself be used to distinguish muds of this type. Although the degree of gelation in muds of this type is usually somewhat higher than muds possessing normal temperature response, there can be appreciable overlap between the two types. The important criterion is the retention or loss of thixotropic response following high temperature aging.

High Temperature Solidification

The most severe reaction to temperature is often referred to as high temperature solidification. In this case, a more complex rigid structure is formed which in severe cases approaches a cement-like solid consistency.[5] These muds usually have lost any resemblance to a thixotropic fluid and upon agitation may tend to granulate and crumble into a discontinuous mass.

RESEARCHING THE PROBLEM

There exist two distinct aspects of the high temperature problem: (1) stability required for a drilling mud, and (2) stability required for "packer muds." This study was conducted to develop a method for stabilizing the properties of a shale control mud when drilling at elevated temperatures. This stability must be accomplished without dislocating the shale controlling properties of a shale control mud

Table 1. Effect of High Temperature on Eight Weighted Drilling Mud Systems used in the Field Today.

Well	Mud type	Mud wt lb/gal	Shear* lb/100 sq ft after 24 hr aging 350F
A	Low lime	17.1	7000
B	Gyp—Q-broxin	17.6	3900 @ 320F
C	Shale control	17.2	5475
D	High pH lime	17.6	6000 @ 36 hr
E	Low lime	10.5	720
F	Gyp—Q-broxin	11.2	775 @ 320F
G	Shale control	10.5	570
H	High pH lime	14.4	500

*Measurement described in section on "Laboratory Studies."

Table 2. Typical Properties of an Unweighted Shale Control Mud

Weight	10.0 lb per gal
Viscosity	38 — 50 sec
Gel Values:	Stormer
Initial	0 gm
10 minute	5— 40 gm
Shearometer Values*	
Initial	Less than 0^6
10 minute	Less than 8
API water loss	6 — 8 cc/30 min
Cake thickness	2/32 in.
pH	12±
P_m	8 — 10 cc N/50 H_2SO_4
P_f	0.5 — 1.0 cc N/50 H_2SO_4
Calcium ion	400 — 800 ppm

*In this and all subsequent tables, shearometer values are determined according to API RP29, 4th Edition (May 1959), "Standard Field Procedures for Testing Drilling Fluids," wherein superscript values are used to denote the time in seconds for complete submergence of the shear tube.

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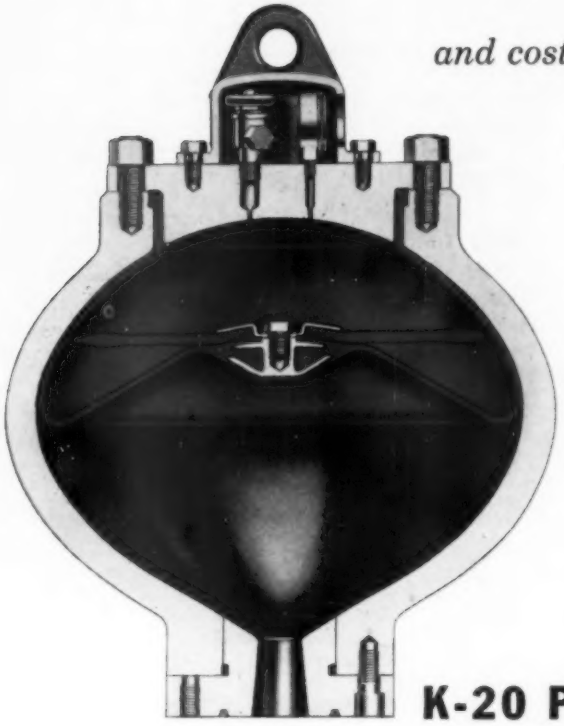

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so that the mud remains useful to drill the sensitive shale sections. For this reason the tests conducted were limited to short duration, i.e. normally 24 hours or less.

The degree of gel structure development under static test conditions was measured by means of an extended range shearometer similar to that used by Watkins and Nelson.[6] This instrument extends the standard shear value determination from 60 to 20,000 lb per 100 sq ft. Following high temperature static aging, mud samples were refluidized, where possible, and the viscosity and chemical properties of the heated sample compared with the original properties. In the dynamic tests, the high temperature aging cells were continually subjected to end over end rotation during the heating period and the properties compared before and after heating.

Time-Temperature-Solids

Preliminary studies indicated that the high temperature reactions of shale control muds possess the typical Time-Temperature-Solids relationships; i.e. increased time, higher temperature, or increased reactive solids normally increase the rate and/or degree of high temperature gelation.

Studying the simple expedient of maintaining a low reactive solids mud indicated that this would greatly benefit, but not solve, the high temperature gelation problem.

Composition Effects

An evaluation of this approach indicated that minor variations in high temperature performance appeared likely by varying shale control reagent compositions with presently available commercial chemical ingredients. However, any major changes in the high temperature performance would probably require development of new and improved component chemicals.

Reversibility of High Temperature Effects

It was found that the high temperature deterioration of the physical and chemical properties of shale control muds is reversible and additional chemical treatment appears to show no indication of detrimental accumulative effects.

Table 3 shows the effect of high temperature deterioration on the chemical and physical properties of a shale control mud and the reversibility of the physical properties effected by reagent addition to restore the chemical balance of the systems.

High Temperature Additive

The stabilization of shales by shale control chemistry is effective over a wide range of mud chemistry because shale control resides in the maintenance of certain minimum alkalinity conditions in the presence of the proper minimum free calcium ion environment. Maximum conditions are not

Table 3. Effect of High Temperature Deterioration of a Shale Control Mud and the Reversibility of These Properties by Reagent Addition to Restore Chemical Balance.

	cpe viscosity		Mud alk	Filtrate alk	Calcium content
	600 RPM	100 RPM	P_m	Pf	ppm
Original shale control mud.....	47.8	118.8	8.0	1.1	680
Heated 8 hr @ 300F.....	180+	1000+	2.7	0.5	680
Shale control mud chemistry restored.	23.1	45.8	10.4	1.6	960
Reheated 16 hr @ 300 F.....	180+	1000+	4.2	0.4	880
Shale control mud chemistry restored.	29.9	64.1	9.5	1.2	960
Reheated 16 hr @ 300F.....	180+	1000+	4.4	0.4	1080

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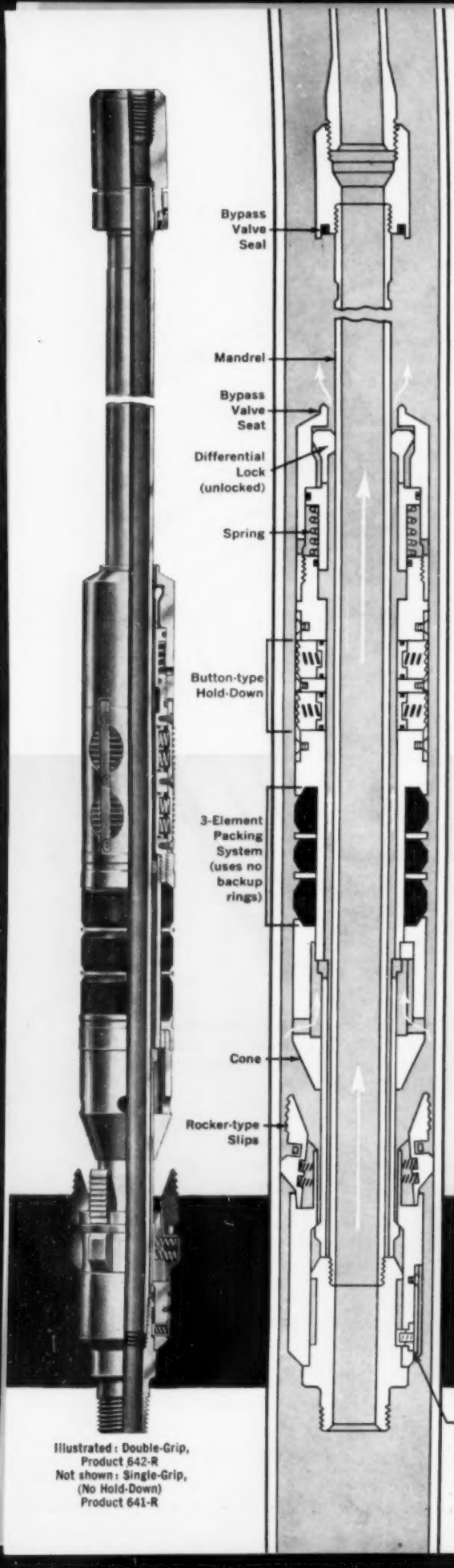


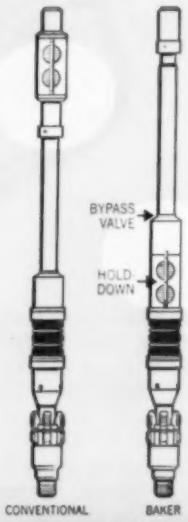
Illustrated: Double-Grip, Product 642-R
Not shown: Single-Grip, (No Hold-Down) Product 641-R

A new concept in retrievable casing packers

BAKER MODEL "R"

DOUBLE-GRIP RETRIEVABLE CASING PACKER

- **An advanced new long-stroke (30″) packer... with simple one-turn-right control-pin setting, automatic bottom and integral hold-down.**
- **Designed for combination acidizing, fracturing and production operations.**



LOCATION OF THE HOLD-DOWN IS FUNDAMENTAL TO THE NEW CONCEPT

In most conventional long-stroke packers, the hold-down is attached in afterthought-fashion to the mandrel, above the bypass valve. Hold-down buttons are directly exposed to button-dulling pressure surges in the tubing and to particle-bearing fluids that may deposit solids behind them. The bypass valve cannot be used to equalize pressures.

In the Baker Model "R" Packer, the hold-down is an integral part of the packer, below the bypass valve. This new concept restores surface control of the bypass valve for pressure equalization.

PERFORMANCE-PROVED FEATURES

The new design concept alone would doubtless make the Model "R" a superior packer. But it offers much more. For into it Baker has built components of the type proved on their high-performance service tools... features like those shown at right, and never before available in long-stroke packers.

Today's practice of fracturing and acidizing in combination with production—both initially and later—requires a new type of packer. It must dependably hold pressures from below and at the same time perform as an efficient production packer. It must be simply run and easily retrieved by the operator.

Afterthought Hold-Downs Not the Answer

Conventional long-stroke packers with a hold-down added to the mandrel as an extra cannot fully meet this need—they were never really designed for this kind of use.

The added hold-down created problems, and often did not hold dependably. Operators found that hold-down buttons would dull on the way in. The packer often proved difficult to release as there was no simple way to equalize pressure across the hold-down, and sand or frac materials tended to keep the buttons from retracting.

A New Concept Was Needed

In designing the Model "R" Packer to meet the operator's needs, Baker came up with a whole new concept. As explained below, button dulling has been minimized because the ample bypass area is completely isolated from pressure surges in the tubing. Pressure differentials across the hold-down and the packer can be instantly equalized by simply picking up on the tubing. The mandrel can be used as a jar at any time, as it is not held inoperative by the hold-down.

To the many advantages brought about by a new design approach, Baker added high-quality, performance-proved components never before found on long-stroke packers.

Baker Stands Behind Every Packer

Back of the Model "R" is the Baker Service Organization. Domestically, 62 Baker field-service warehouses stand ready to supply packers, parts and repair service. Over 400 Baker servicemen are available to help you in planning applications for this packer. Why not ask one of them to tell you more about the great new Model "R" Packer.

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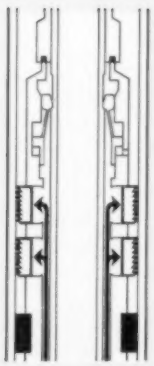
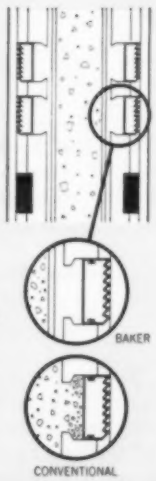
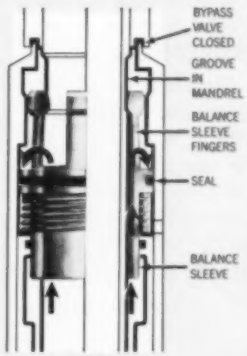


HOLD-DOWN IS ACTUATED BY PRESSURES FROM BELOW PACKER. The hold-down buttons are isolated from pressure surges in the tubing. Surface bleed-off is never required, as the bypass valve can be opened at anytime. Pressure differentials can be instantly equalized, even if the tubing is plugged.

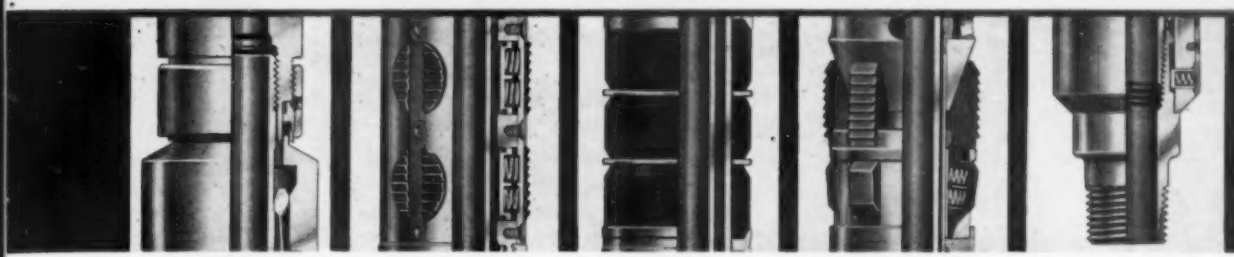
BUTTONS ARE ISOLATED FROM CONTAMINATED FLUIDS. Sand and other solids cannot build up in back of the buttons and thus interfere with button retraction.





UNIQUE DIFFERENTIAL LOCK HOLDS BYPASS VALVE CLOSED. Shown at left, in relation to the packer body, is the Balance Sleeve which forms an important part of the Differential Lock. Note how pressure differentials from below the packer act on this sleeve to force it down so that the fingers of the sleeve wedge into the groove in the mandrel. The very pressure that acts to pump the valve open thus acts to keep it closed—eliminating the need for high tubing set-down weights.

UPWARD MOVEMENT OF TUBING RELEASES LOCK. No rotation or pressure equalization is required.



NEW FACE-SEAL BYPASS VALVE
Instant acting—seals on contact, opens with ¼" pickup. Overcomes plugging and sticking.

PRECISION HOLD-DOWN BUTTONS
Precision fitted to minimize sticking and fouling. Tapered upper surface of teeth aids retraction.

THREE-ELEMENT PACKING SYSTEM
Proven Baker design. Holds under extreme conditions, releases readily. Uses no metallic back-up rings.

DEPENDABLE ROCKER-TYPE SLIPS
Simple, compact, trouble-free. Won't wedge or stick. Performance proved on Baker service tools.

NEW AUTOMATIC BOTTOM
Automatically locks slips in retracted position when tubing is raised the full stroke of the mandrel.

so critically defined; therefore, it is possible to adjust chemical levels to compensate for the high temperature effects on the shale controlling chemistry.[4]

The effect of compositional variations upon the physical properties of the shale control mud systems is much more critical. In the use of a mud system for successfully performing its drilling functions, it is essential that it possess stable physical properties. For this reason the most direct approach to combatting high temperature sensitivity of shale control muds would be the development of a chemical agent which would stabilize the physical properties in the presence of high temperatures. A further requirement was that the agent would not affect the shale solidifying reaction between the mud and the shales.

One class of compounds found to be particularly effective for this purpose is the anionic chromium compounds such as sodium chromate and sodium dichromate. When a shale control mud is treated with this type of compound, the physical properties are rendered remarkably less temperature sensitive.

Table 4 shows the effect of pretreating the original shale control mud of Table 3 with 1½ lb per bbl of sodium chromate tetrahydrate before subjecting it to repeated heat treatment.

Comparing Tables 3 and 4, it can be seen that, although chemical properties varied in the same order of magnitude in both cases, the physical properties of the chromate treated mud were practically immune to the effect of the temperature. There appears to be no characteristic chromate effect on any of the conventionally measured chemical or physical mud properties before heat treatment. This is characteristic of all of the work with the chromate treatment. In field evaluation and control, it is necessary to rely solely on high temperature aging tests. This test also shows that the effect of the chromate was not transient, for it remained effective throughout several heating cycles and was not destroyed by subsequent chemical treatment with shale control reagents.

FIELD EVALUATION PROCEDURES

In order to assist in the early identification of high temperature sensitivity as well as evaluate and maintain control on the field application of chemical modifiers, a test procedure was adopted based upon use of conventional static high temperature aging cells[5] and the extended range shearometer. Since the problem was control of high temperature effects in drilling mud systems, the following factors were considered of primary importance in developing a satisfactory test for field application.

Table 4. Effect of Pretreating Original Shale Control Mud of Table 3 with 1½ lb per bbl of Sodium Chromate Tetrahydrate Before Subjecting It to Repeated Heat Treatment.

	cpe viscosity 600 rpm	cpe viscosity 100 rpm	Mud alk P_m	Filtrate alk P_f	Calcium content ppm
Original shale control mud.....	47.8	118.8	8.0	1.1	680
Original shale control mud +1½ lb/bbl $Na_2CrO_4 \cdot 4H_2O$....	42.0	104.0	8.0	1.3	840
Heated 8 hr @ 300F.	27.7	97.1	3.1	0.4	360
Shale control mud chemistry restored.	30.4	59.5	7.2	1.7	760
Reheated 16 hrs @ 300F.....	69.4	177.8	3.7	0.5	620
Shale control mud chemistry restored.	34.3	43.5	9.2	1.9	880
Reheated 16 hr @ 300F.....	39.4	59.5	4.9	0.5	760

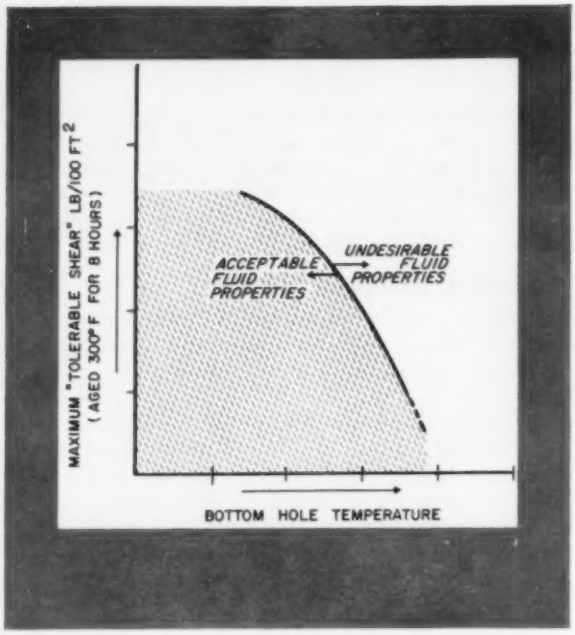

MAXIMUM "TOLERABLE SHEAR" LB/100 FT²
(AGED 300° F FOR 8 HOURS)
ACCEPTABLE FLUID PROPERTIES
UNDESIRABLE FLUID PROPERTIES
BOTTOM HOLE TEMPERATURE

FIG. 1. **Maximum "tolerable shear" vs bottom-hole temperature** relationship for shale control muds at constant low gravity solids content.

(1) **Temperature** — The temperature selected should be sufficiently high to insure deterioration and reaction of chemical constituents at a reasonable rate.

(2) **Time** — The rate of reaction should be such that the desired degree of deterioration would be accomplished within a period of time that could be used in field control practices.

(3) **Physical Properties Effects** — The reaction should be allowed to progress to the extent that the physical properties of unprotected samples suffer serious dislocation.

(4) **Chemical Property Effects** — The reaction time should be selected so that the chemical balance in the mud system is not radically deteriorated.

Based upon experience, a test procedure of 8-hr aging under static conditions at 300F was selected for routine study and field control procedures.

Following the 8-hr and 300F static aging a shear value of the mud is determined, the mud tested for refluidizing characteristic, and the resulting chemical balance determined.

Maximum "Tolerable Shear" vs Bottom-Hole Temperature

Shale control muds under most shale drilling conditions carry a very high content of low gravity reactive clay-shale solids. Laboratory evaluation has shown that at a given chemical level the shear value measured on 300F and 8-hr aged samples normally increases with the solids content. Field experience further indicated that as the bottom-hole temperature rises, the permissible 300F and 8-hr shear

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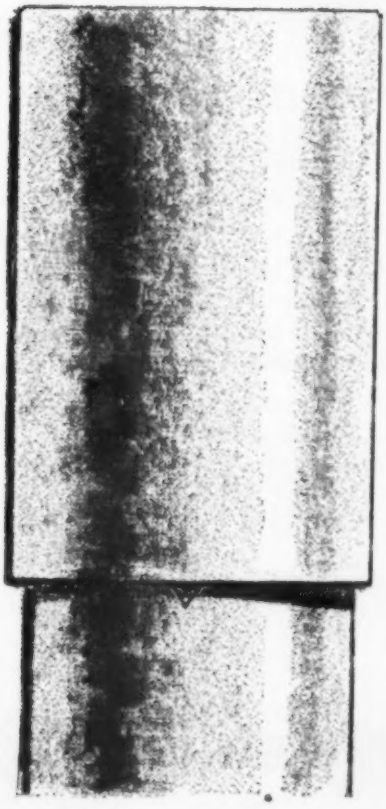

Deep wells you are planning call for special steels and special joint designs tailored to the job.

Such a safe, economical product is Pittsburgh Seamless Buttress Thread Casing made by one of the country's pioneer seamless producers. The threaded connection is virtually as strong as the body of the pipe. It can support long casing strings and withstand tremendous stresses.

Available in all popular sizes of outside diameters, new Pittsburgh Steel Buttress Thread Casing gains its extra strength from longer length of threads on casing and reduced flank angle of engaged threads. As a result, the load is distributed over the full pipe cross-section.

Rapid stabbing and spinning are assured. Since there is no internal upset, inside clearance is the same throughout the entire string.

Coupling threads engage casing threads throughout their entire length since the ¾-inch taper per foot is continuous without fast angle vanishing threads. Five threads per inch and the three degree flank angle of threads permit threads to support the full weight of casing in the well. Write for literature and further information.

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If only oil and water would never mix . . . but sometimes they do! And when they mix within a formation, the results can be a production-robbing emulsion problem.

To fight emulsion blocks in all their forms and to intensify the performance of other production stimulation techniques, Halliburton has developed surfactants to alter the surface tension and interfacial tension characteristics of produced and treating fluids to help eliminate trouble in a treatment *before* it can happen.

Knowing which Surfactant, *if any*, is needed to help a well, is part of your Halliburton man's training. His experience is augmented by his company's experience in performing over *three million* oilfield service jobs. Put this knowledge to work for *you*. Call Halliburton.

PROGRESS FOR THE INDUSTRY THROUGH CONTINUING RESEARCH

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. . . with these Halliburton Surfactants

HALLIBURTON HYFLO . . . a special blend of surfactants designed for production improvement where either a water block or emulsion block exists. Entering with the fracturing oil, Hyflo tends to destroy these blocks, lowering breakdown pressures of the fracturing treatment. Hyflo is also used with native crude to break up water blocks and water-oil emulsions near the well bore to help increase production.

MORFLO II . . . Similar in action to Hyflo. However, it is most often used in an aqueous or acid carrier. Some applications are – a conditioner for maintaining compatibility in water-base fracturing fluids . . . a component in Mud Cleanout Agent and Mud Flush . . . and as a treating agent for water used in killing wells.

WATER REMOVAL

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HALLIBURTON HOWCO-SUDS . . . now available in liquid or stick form and designed to be used – for helping remove water from partially drowned gas wells . . . to speed up recovery of water after Waterfrac treatments . . . as a surfactant in acidizing gas wells, injection wells, and disposal wells . . . as an aid to purging water in air and gas drilling. Howco-Suds is also a good lubricant in water which helps extend the life of swab cups.

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WAC-8 . . . a Halliburton chemical agent used with all types of acid and water base fluids to lower the loss of fluid to matrix permeability along a fracture crevice. This allows deeper lateral penetration of the treatment.

TEMGEL . . . a hydrocarbon base fluid with delayed gelling action for placement. The material is designed to revert to a thin liquid after a pre-determined length of time. Its composition is compounded for each well depending on well conditions. This mixture will aid in eliminating "thief zones." It can be used in stages to obtain a more even stimulation treatment throughout a productive zone.

TLC . . . a temporary lost circulation compound, is useful in sealing and bridging fractures allowing treating fluids to be deflected into less permeable sections. It is very often used in stages of a stimulation treatment.

Halliburton has an unequaled selection of chemical solutions to downhole problems. For help with your well problems, see your Halliburton man.

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Table 5. Shale Control Mud Flow Properties of Pit Samples from Caillou Island Well Before and After Adding 1½ lb per bbl Sodium Chromate Tetrahydrate.

	PIT SAMPLES		FLOW-LINE SAMPLES	
Time	Wt (lb/gal)	Visc (sec)	Wt (lb/gal)	Visc (sec)
8:00 PM	15.8	62—Chromate treatment started	15.8	91—Sample A
9:00 PM	15.8	59	15.7	95
9:30 PM	15.8	58	15.8	100
10:00 PM	15.7	58	15.6	103
10:30 PM	15.7	58	15.6	100
10:45 PM	15.7	58	15.8	83
11:00 PM	15.6	56	15.5	66—Chromate treated mud returns
11:15 PM	15.7	54	15.7	62—Sample B
11:30 PM	15.7	54	15.7	62
12:00 M	15.8	53	15.7	62
1:15 AM	15.8	53	15.6	63
2:30 AM	15.8	53	15.7+	57

Table 6. Effect of 8-Hour Aging at 300F on Samples Designated A and B in Table 5.

	A (no chromate)		B (chromate treated)	
	Before heating	After heating	Before heating	After heating
Gel*				
0 min	1 (F)	60+	0 (F)	0[3]
10 min	6 (F)	60+	3 (F)	13.0
API water-loss	5.6 cc	5.6 cc	6.0 cc	7.5
P_m	9.3 cc	8.0 cc	8.4 cc	7.5
P_f	1.3 cc	0.9 cc	1.3 cc	1.0
Salt	7300 ppm	8000 ppm	8000 ppm	8000 ppm
Ca^{++}	480 ppm	560 ppm	340 ppm	280 ppm
% solids	31.0			
Shear in lb/100 ft²	1150			270
Appearance after heating		Plastic		Fluid

*Samples marked (F) indicate determinations using a Fann VG Meter; other values determined by shearometer.

value, which a mud can exhibit and still retain satisfactory drilling mud properties, is reduced. Fig. 1 presents schematically this relationship.

A relationship such as Fig. 1 is possible with the unmodified shale control mud since the system falls under the category of a mud which becomes a highly viscous semi-plastic fluid after gelation under the influence of temperature. After treatment with chromates, such a relationship does not appear applicable since the important factor in the chromate modification is the conversion of the mud from one which becomes a highly viscous fluid after heating to one which refluidizes readily to a useful mud possessing a stabilized viscosity.

FIELD APPLICATION — CASE HISTORIES

Caillou Island (Louisiana Coast)

An application of sodium chromate in the Caillou Island Field was a remedial measure on a shale control mud which would not respond to normal treatment. The well had been drilled to 18,638 ft, at which depth it was desired to ream the hole to full gauge. While reaming, the drill pipe stuck at approximately 17,950 ft. Drill pipe was backed off at 16,550 ft leaving 1400 ft of fish in the hole and "washover" procedures were started. No particular difficulty was encountered in running the wash pipe or washing over approximately 500 ft of the fish but, when the cutting tool was run, circulation could not be established.

The last logging temperature at 18,300 ft was in excess of 275F. Flow properties of the shale control mud showed the characteristic unbalance, indicating high temperature deterioration. Table 5 shows the imbalance in flow properties existing in the mud stream wherein pumping the preconditioned mud through the well resulted in an increase of the funnel viscosity from 58-60 seconds to 95-105 seconds.

Pilot tests using 1½ and 3 lb per bbl of sodium chromate tetrahydrate indicated that the 1½ lb per bbl addition would be adequate. Shear tests run after aging at 300F. for 8 hr showed that the 1½ lb per bbl of sodium chromate treatment reduced the shear from 1150 lb per hundred sq ft to a 200-250 lb per hundred sq ft range, as well as improving the flow properties after high temperature aging from a plastic to a fluid state.

On the rig, 1½ lb per bbl sodium chromate was added to the system through the chemical barrel. Table 5 shows the actual equalization of funnel viscosities which occurred after the first circulation. On rerunning the cutting tool,

Table 7. Results of Shear Tests of Samples After Temperature Treatment, Bay St. Elaine Well No. 6.

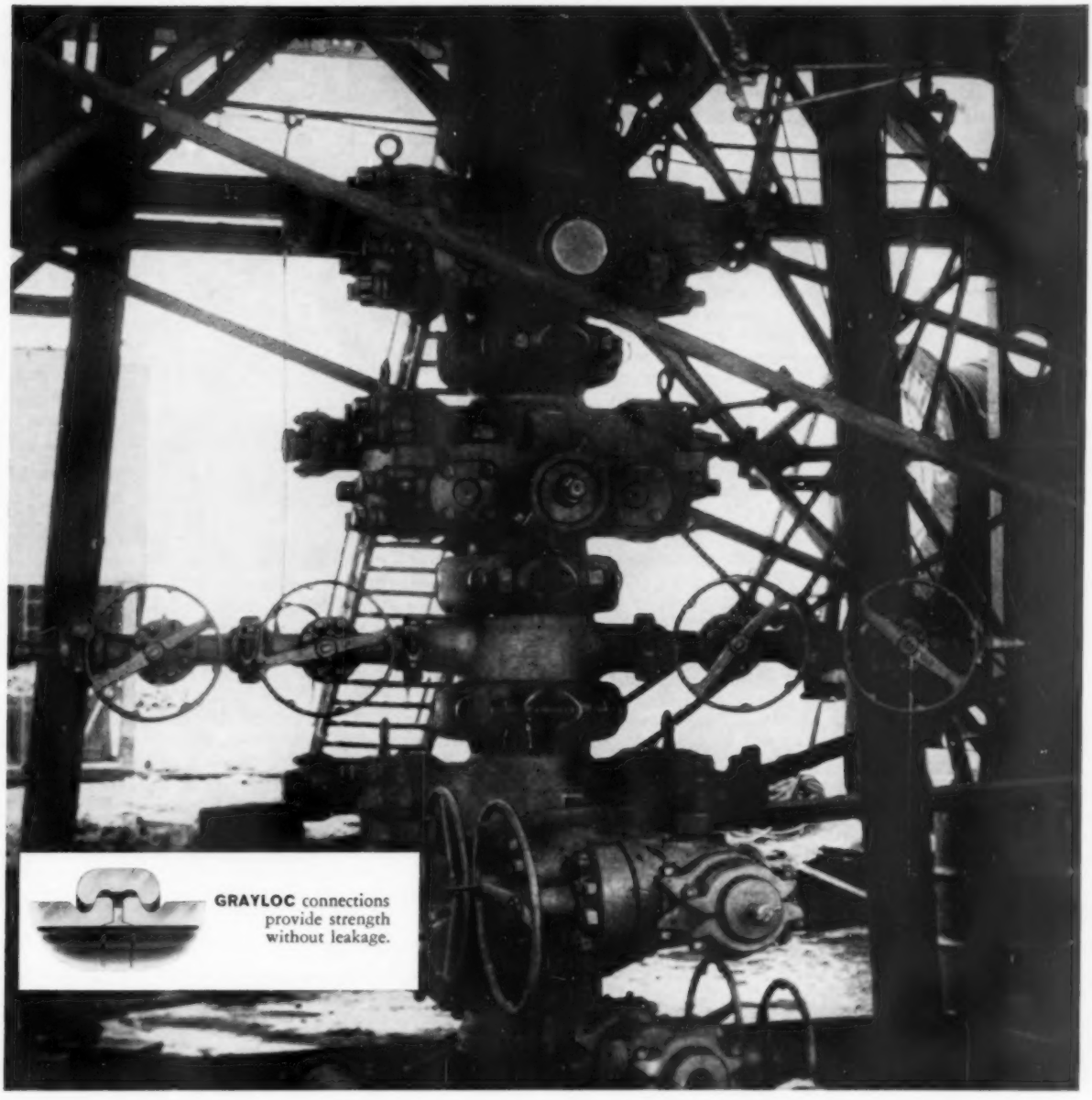
Date sampled	Depth	Weight lb/gal	Viscosity sec	Shear after 300F aging lb/100 ft² 8 hours	24 hours
1. 9-27-58 (Low pH mud).	10,300	10.0	55	155	233
2. 9-30-58 (shale control mud)...	11,065	10.2	40	160	463
3. 10-15-58.....	12,500	11.3	42	—	1277
4. 10-24-58.....	13,085	11.7	55	930	1185
5. 11-4-58.....	14,012	11.8	56	1275	3500
6. 11-6-58.....	14,159	11.8	53	1080	2700
7. 11-14-58.....	14,566	11.7	51	1370	2500
8. 11-21-58.....	15,000	12.6	50	1400	3150
9. 12-9-58.....	15,710	12.6	52	780	4450
10. 1-13-59.....	16,630	13.5	47	1975	4000
11. 2-5-59.....	17,304	14.1	64	6000*	—
12. 3-13-59 (after sodium chromate added to mud system)...	18,138	15.7	64	300 350*	—

*Aging Temperature 350F.

Table 8. Pilot Tests Using Sodium Chromate in Samples From Bay St. Elaine Well No. 6.

Date sampled	Depth	Weight lb/gal	Viscosity sec	Shear After 300F Aging lb/100 ft² 8 hours	24 hours
1. 10-24-58.....	13,085	11.7	55	930	1185
(1)+1 lb/bbl sod. chromate				300	552
(1)+2lb/bbl sod chromate				300	575
(1)+3 lb/bbl sod chromate				290	480
2. 11-21-58.....	15,000	12.6	50	1400	3150
(2)+1lb/bbl sod chromate				290	825
(2)+2lb/bbl sod chromate				290	725
(2)+3 lb/bbl sod chromate				280	480
3. 2-5-59.....	17,304	14.1	64	6000*	—
(3)+1½ lb/bbl sod chromate				220*	—
(3)+1 lb/bbl sod bichromate+¼lb/bbl caustic soda				210*	—
4. 3-13-59 (After sodium chromate added to mud system).....	18,138	15.7	64	300 350*	—

*Aging Temperature 350F.



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It took a native crew less than six hours to nipple-up this Grayloc equipped well head and control assembly, and it required approximately 24 inches less substructure height than a comparable flanged hook-up.

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circulation was easily established and the fish recovered without difficulty.

High temperature aging tests at 300F. for 8 hr, as shown in Table 6, fully substantiated the pilot tests in showing that the actual mud system after chromate treatment possessed a shear of 270 lb per hundred sq ft and could be refluidized readily to a pumpable state.

Following the chromate treatment it was noted that the calcium level of the shale control mud had dropped quite radically. This was chemically adjusted to the perferred shale control range of 400 ppm plus, at which time an additional ½ lb per bbl of sodium chromate was added. Following this adjustment the high temperature shear as measured after 300F for 8 hr remained in a range of 270-450 lb per 100 sq ft for the remainder of the operations.

Referring to the previous section discussing "maximum tolerable shear," the original unmodified Caillou Island shale control mud is an example of a mud possessing a relatively low "maximum tolerable shear." The system was extremely sensitive to the well bore temperature, yet the high temperature shear *as measured* (after 8 hr at 300F) was only 1150 lb per hundred sq ft. This substantiated laboratory findings that routine high temperature aging tests are not always sufficient to characterize temperature instability.

Bay St. Elaine (Louisiana Coast)

Another application of chromate was as a remedial measure in a down structure offset well of the original Bay St. Elaine well series.[3] A review of the shale control mud performance records on Bay St. Elaine No. 5 Well gave strong indication that incipient high temperature gelation might have been developing at total depth. When the deeper Well No. 6 was proposed, the high temperature chromate modification was considered. Well No. 6 was closely observed and sampled with a view to adding chromate when indicated by well conditions.

The mud on Well No. 6 was converted to a shale control system at 11,000 ft in open hole and drilling proceeded to 16,193 ft where 7-in. casing was set. Tables 7 and 8 present data obtained on samples collected throughout this period and show the increase of shear in the untreated mud and the results of pilot tests using chromate. At a depth of 16,630 ft, the shear after 8 hr at 300F had increased to 1975 lb per hundred sq ft. Based on this and a prior history of log temperatures in excess of 230F for this general area, field personnel were notified of the possibility of high temperature gelation. At a depth of 17,252 ft, difficulty was encountered in running a logging tool at a recorded log temperature of 252F.

Although the logging tool went to bottom on the third run, 1½ lb per bbl chromate was added when drilling was resumed. In this well, sodium bichromate was used. Procedure at the well site consisted of reacting in water 1 part of sodium bichromate with ¼ part caustic soda in the chemical barrel to form the equivalent of 1½ parts of sodium chromate tetrahydrate. The solution of sodium chromate was then added over one circulation to give a concentration of 1½ lb per bbl.

The addition of chromate reduced the high temperature (8 hrs at 300F) shear from 4000 to 240 lb per hundred sq ft. In addition, the viscometric properties after heating were changed from "plastic" to "readily refluidized." Further evidence of the beneficial effect of the chromate was reflected in a reduction of the funnel viscosity of the mud at the flow line from 80-90 sec to 56-60 sec.

After the addition of sodium chromate, the shale control chemistry of the mud was adjusted and normal treatment was maintained.

Table 9. Performance of Mud Samples After Chromate Treatment, Bay St. Elaine Well No. 6.

Date sampled	Depth	Weight lb/gal	Viscosity sec	P_m	Ca^{++} ppm	Shear 300 F lb/100 ft² 8 hr	After aging refluidized
1. 2-7-59 (Before)	17,304	13.7+	80	9.1	840	4000	No
2. 2-7-59 (After)	17,315	14.1	56	8.2	640	240	Yes
3. 2-11-59 (Stuck pipe)	17,471	14.9	58	10.0	680	250	Yes
4. 2-25-59 (Recovered fish, drilling ahead)	17,516	15.0	60	9.0	890	315	Yes
5. 3-4-59	17,774	15.0	60	8.2	1000	325	Yes
6. 3-13-59 (Total depth)	18,138	15.7	64	8.9	960	300	Yes

Drill pipe was struck while making a connection at 17,471 ft. The fish was recovered without incident and without any modification of the mud system. The well then drilled to a total depth of 18,138 ft with a recorded log temperature of 282F at 18,000 ft.

Throughout the five weeks required to drill this additional 834 ft under elevated temperature conditions, no additional chromate treatment was required. The mud was maintained with effective shale control chemistry by routine treatment and the mud weight progressively increased from 13.7 to 15.7 lb per gal.

Table 9 presents data on the performance of the shale control mud during the interval after chromate treatment and shows the remarkable stability of high temperature shear and refluidizing character of the mud following chromate modification.

It was observed during this 834-ft interval that significantly less chemical treatment was required to maintain the mud than had been anticipated from the treating requirements before the chromate addition.

Safety

Chromate salts are toxic and could be hazardous if carelessly handled. However, many other materials now in use such as caustic soda, formaldehyde, barium carbonate, etc. are also toxic. When dissolved in a mud stream the chromate concentration present is such that toxicity should represent no problem. As with the other chemicals, precautions need to be taken primarily when handling the chemical directly or as concentrated treating solutions. Due to the ready solubility of the chromate salts, a minimum of handling is necessary during treatment.

Acknowledgment

The authors thank the operating and engineering groups who assisted in the field application phases of this new shale control mud development, and the management of Texaco Inc. for granting permission to publish this report.

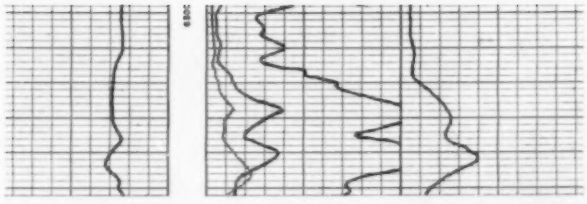
References

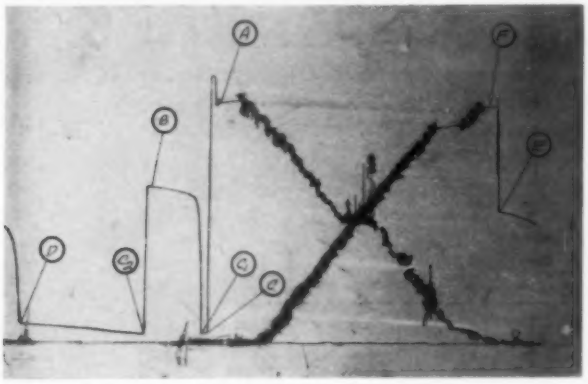
1. Watkins, T. E.: "A Drilling Fluid for Use in Drilling High-Temperature Formations", *API - Drilling and Production Practices*, 7-13, 1953.
2. Burdyn, R. T. and Wiener, L. D.: "That New Drilling Fluid For Hot Holes", *The Oil and Gas Journal*, p. 104-106, Sept. 10, 1956.
3. Weiss, W. J.; Graves, R. H.; and Hall, W. L.: "A Fundamental Approach To Well Bore Stabilization", *The Petroleum Engineer*, April 1958.
4. Weiss, W. J.; Hall, W. L., and Graves, R. H.: "Shale Controlling Drilling Fluids", 5th World Petroleum Congress, Paper 9, Sect. II.
5. Gray, G. R.; Neznayko, M.; and Gilkeson, P. W.: "Some Factors Affecting the Solidification of Lime-Treated Muds at High Temperatures", *World Oil*, March 1952.
6. Watkins, T. E.; Nelson, M. D.: "Measuring and Interpreting High Temperature Shear Strengths of Drilling Fluids", T. P. 3638, *Petroleum Trans. AIME*, 195, pg. 213 (1953).

★ ★ ★

WHICH WELL WAS THE PRODUCER?

WELL "A"

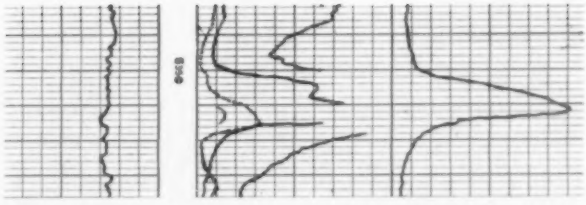


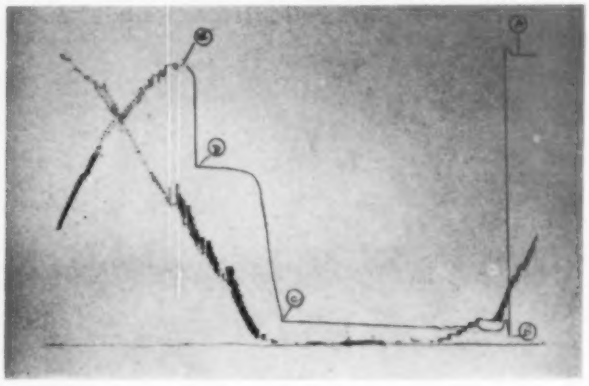


Electric logs on well "A" indicated fair to good permeability. Resistivity was indicative of fluid content. Cuttings showed a good oil stain on the interval 6312—6357. Core analysis and log interpretation left considerable doubt as to whether the zone would be commercially productive. The section showed a good percentage of porosity, fair permeability and 10.6% oil/46.5% water content. To supplement existing data, Johnston Testers performed a three-hour Selective Zone Test on the sand and recovered 125 feet of oil and 700 feet of water.

Casing was set on the well and the zone perforated. The sand was acidized to stimulate production and improve oil/water ratio. Was this well a commercial producer?

WELL "B"





A slight oil show was noticed in cuttings from the sand at interval 5350—5370 shown on the above log. Logs which were run indicated low permeability at this interval. Core analysis verified the low permeability but showed a rather high percentage of porosity and 18.2% oil/36.5% water content. To supplement this data, Johnston Testers performed a four-hour Selective Zone Test and recovered 370 feet of oil and 180 feet of gas cut mud and water.

Casing was set and the zone perforated. The sand was treated to improve the flow characteristics and improve the oil/water ratio. Was this well a commercial producer?

Above Drill Stem Test information, test data and the fluid recovery, indicated a non-commercial producer on Well "A." Subsequent acidizing result was poor. The well was abandoned and plugged.

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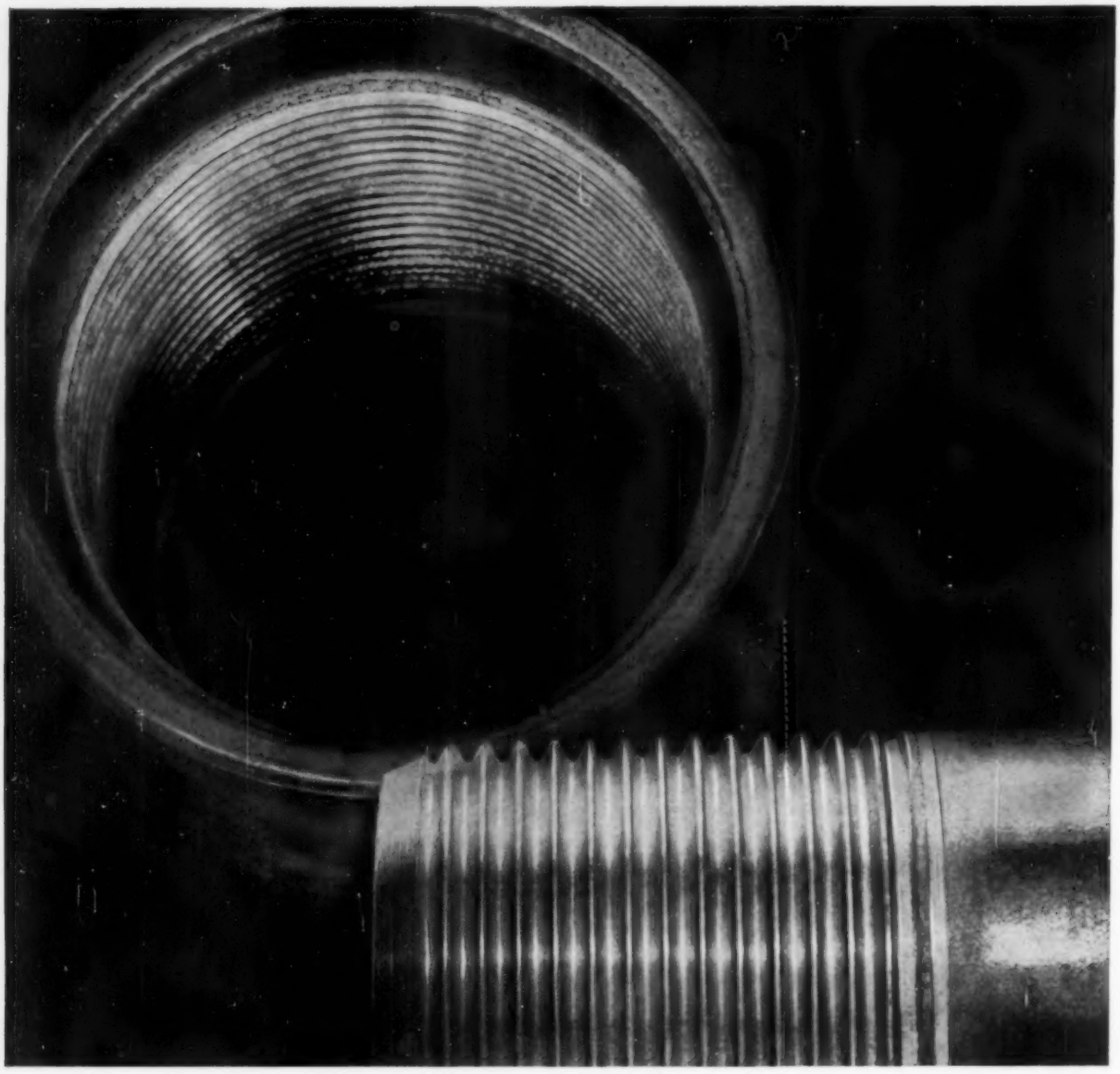

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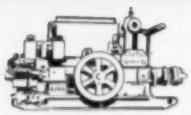

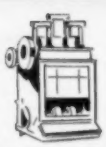

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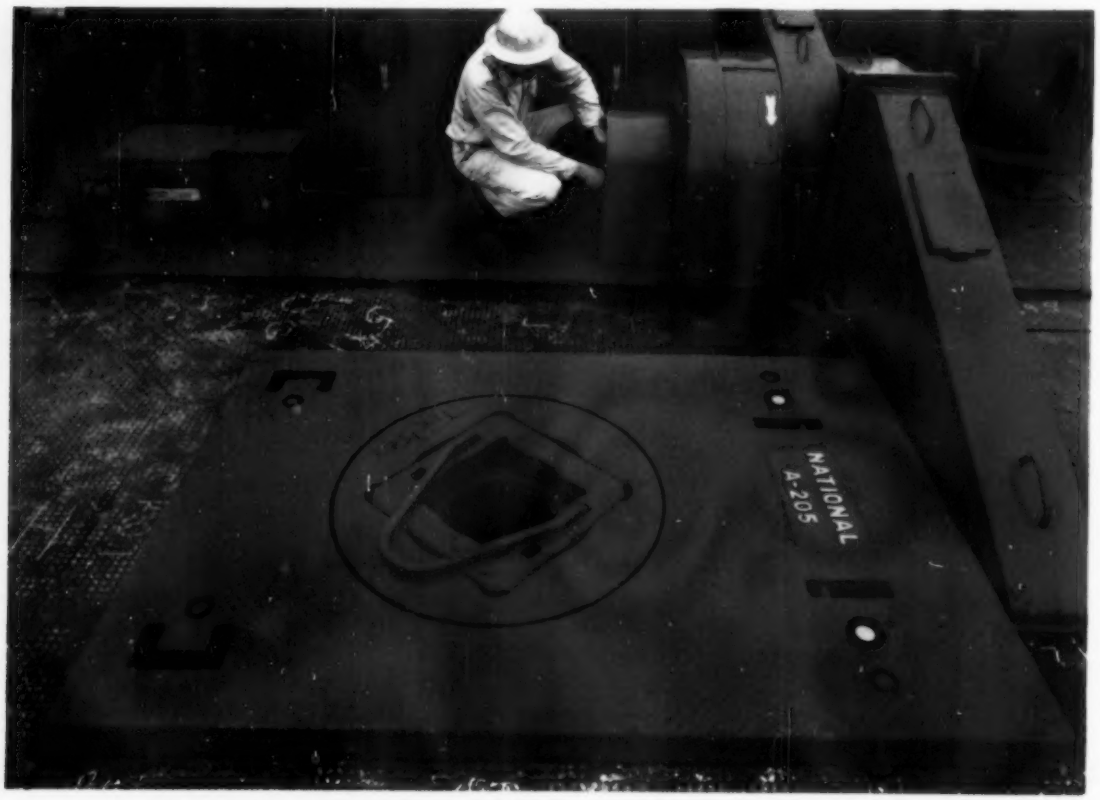

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The second of a two-part article deals with development and application of multiple and tubingless completions

MULTIPLE COMPLETIONS

THE TERM "MULTIPLE COMPLETION" refers to the technique which permits two or more reservoirs to be produced simultaneously but separately through the same well bore. Although most multiple completions are used only for production, many wells of this type serve as multiple injection wells for pressure maintenance or secondary recovery projects, and others are used for the injection of fluid into one or more reservoirs while maintaining production from others.

Technical reports are available on dual completions made during the late 1930's[10]; however, here was no significant application of the technique prior to World War II. The wartime demand for petroleum products and the critical shortage of steel for tubular goods prompted increased utilization of dual completions during the 1940's.[11]

Early dual completions were limited essentially to flowing wells selected to present no problems such as sand production or high pressure. Tools and equipment designed for use in single completions did not perform satisfactorily when subjected to the more severe loading imposed by dual completions; however, in wells where conditions were ideal, the dual completion proved to be a successful tool, offering savings of about 45% in steel consumption and approximately 40% in drilling costs as compared to the drilling of two single wells.[12] Because general experience with dual completions during this period was not entirely satisfactory, a decline in use of the technique occurred during the period 1946 to 1949.

The increased cost of drilling wells and the relatively low additional cost of the second completion revived interest in the dual completion in the early 1950's. Equipment and techniques were rapidly improved, and widespread acceptance of multiple completions followed.[13]

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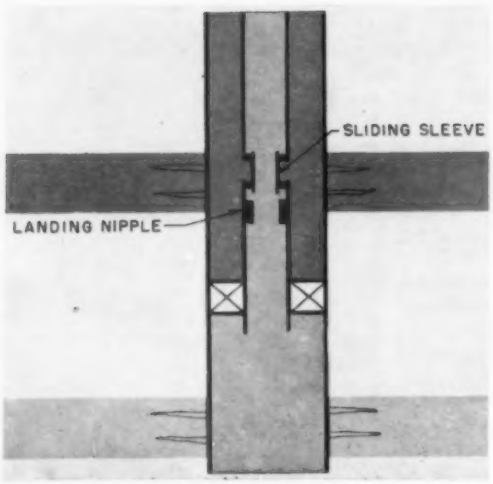


FIG. 10. Single-tubing, single-packer dual completion is one of the oldest types of duals and is still popular because of its simplicity and low initial cost.

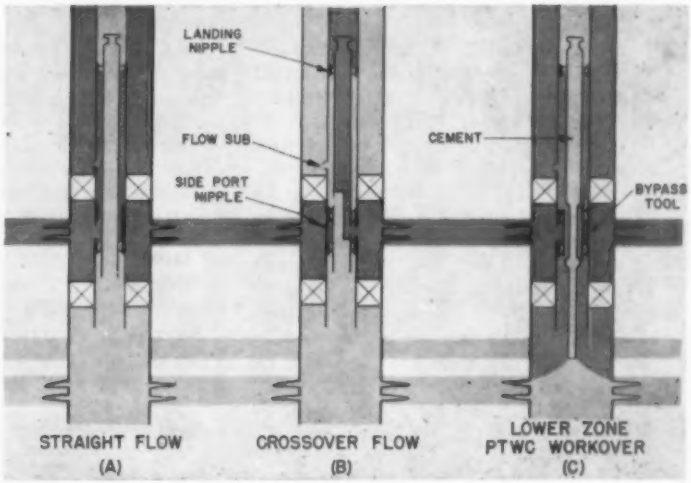
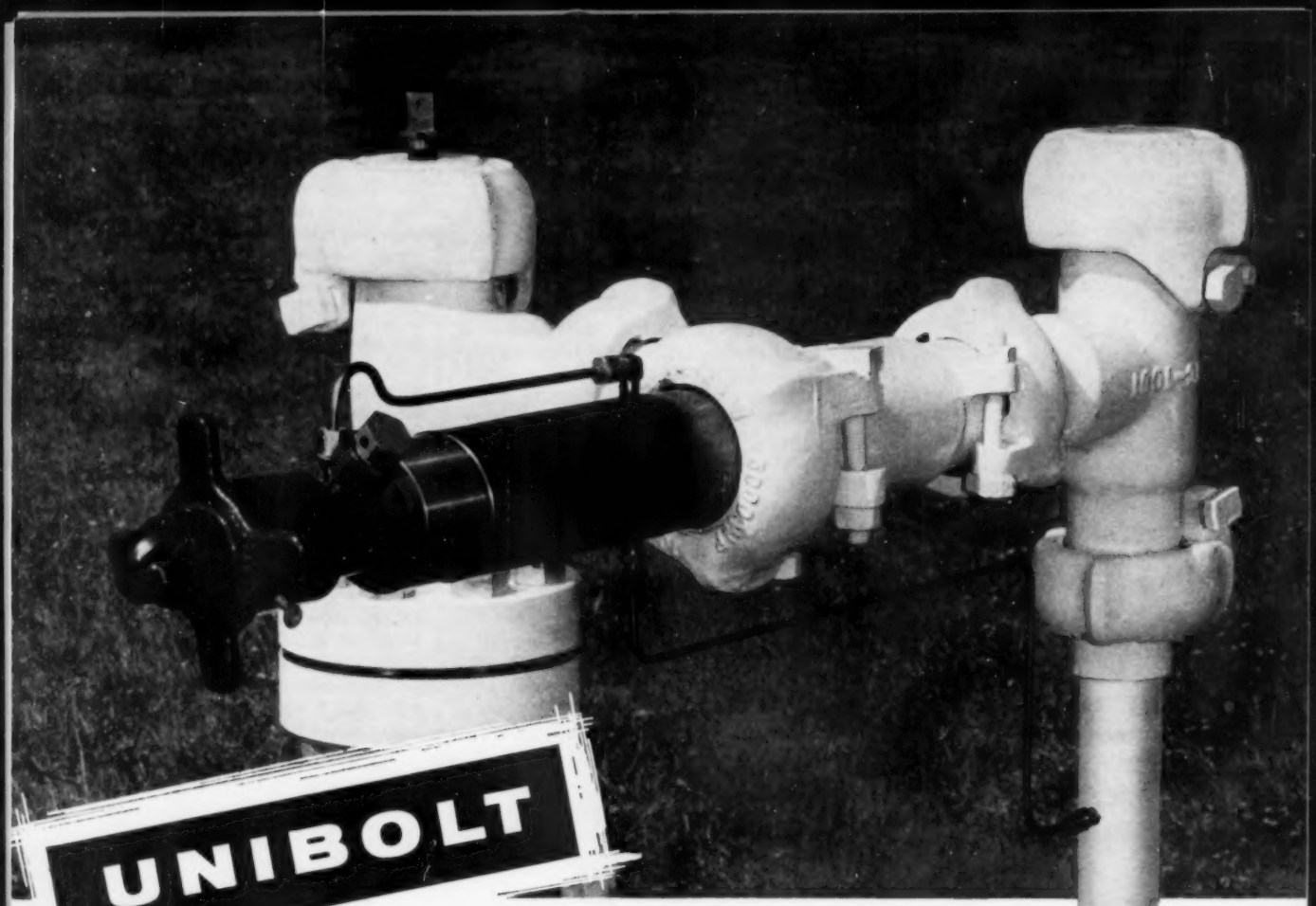


FIG. 11. Single-tubing, two-packer dual completion permits producing either of the two zones through the tubing. Lower zone can be worked over through the tubing, but tubing and packers must be removed for working over the upper zone.



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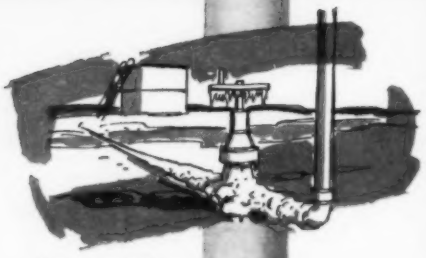
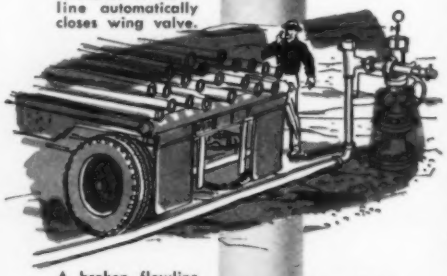
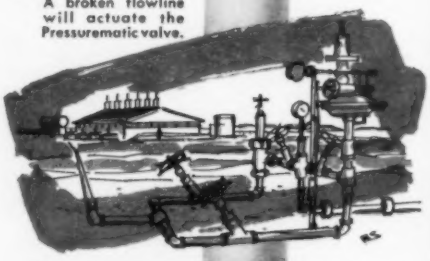


Freezing or hydrate formation in flowline automatically closes wing valve.



A broken flowline will actuate the Pressurematic valve.



Failure of a pressure regulator on pipe line gathering manifold would shut in the well.

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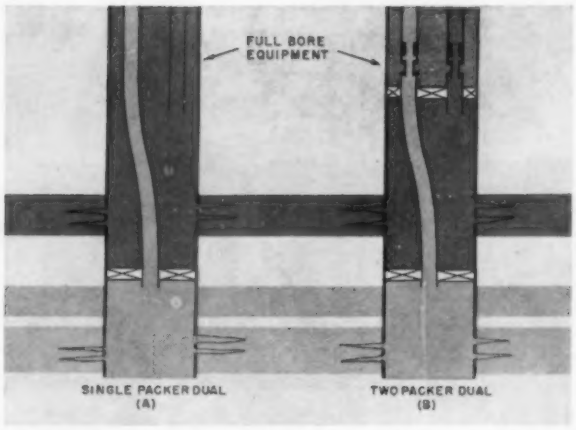

FIG. 12. Parallel-tubing duals can be completed with either one packer (A) or two packers (B). Use of two packers permits gas-lifting both zones from a common gas source in the annulus or pumping both zones individually.

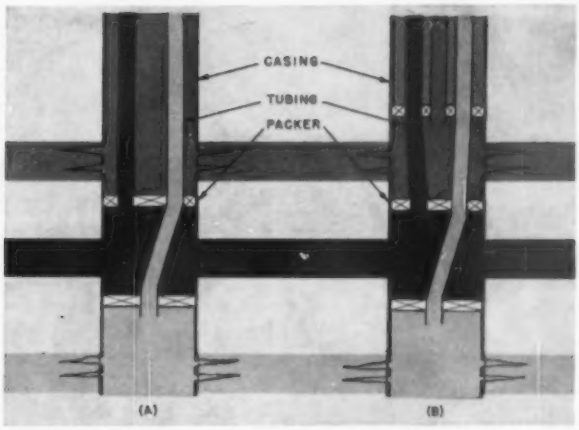

FIG. 13. Triple completion can be made utilizing two strings of tubing and the casing-tubing annulus as flow channels or three strings of tubing with three packers.

DUAL COMPLETIONS

Many different combinations of tubing strings and packers for multiple completions may be utilized, and all equipment required is now commercially available. Selection of a particular installation depends upon economics as influenced by many considerations including installation cost, artificial-lift requirements, corrosion, sand production, and workover requirements. To aid in selecting the optimum-type installation, discussion of dual completion equipment and techniques is given with specific comments on application of the various type installations.[14]

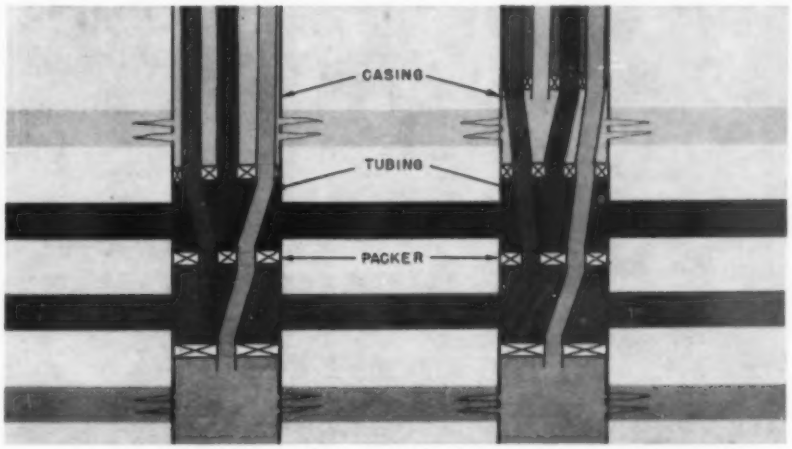

FIG. 14. Quadruple completion is similar to the triple completion in principle and the methods have been used for making quintuple completions.

Single-Tubing, Single-Packer

One of the oldest types of dual completions involves setting a production packer on tubing between reservoirs and producing the lower interval through the tubing and the upper interval through the tubing-casing annulus (Fig. 10). This type completion is still popular because of simplicity and low initial cost. It is applicable where the upper interval is a long-life flowing completion which does not present problems of sand production, severe corrosion, or abnormal pressure.

It is common practice to install full-open packers and tubing equipment in order that through-tubing techniques may be utilized for workover of the lower interval. A wireline-operated circulating valve is usually placed above the packer for initiating flow from the upper zone through the tubing. The circulating valve is closed for normal production.

Workover of an upper zone requires use of a rig and removal of the tubing from the well. Concentric tubing can be used for low-pressure squeeze-cementing of the lower zone or through-tubing dump bailers can be employed for plugback to avoid pulling tubing. Use of the tubing extension for workover of the lower zone is hazardous because the casing-tubing annulus must be used for circulation, exposing the upper zone to workover fluids and to squeeze pressures.

Single-Tubing, Two-Packer

One of the main reasons for using two packers and only one tubing string in a dual installation is to achieve the flexibility of producing either zone selectively through the tubing. This type dual completion utilizes a packer between the reservoirs and a second packer with selective crossover flow equipment above the upper reservoir (Fig. 11A and 11B).

Straight and crossover flow are distinguished by the flow paths of upper and lower zone production; lower zone production through the tubing is considered straight flow while upper zone production through the tubing is defined as crossover flow. The weaker zone, which may not flow through the casing-tubing annulus, can be diverted to the tubing, and production from the stronger zone can be taken through the annulus with this type installation. Similarly, if the pressure of one reservoir is abnormally high, production from this zone can be directed through the tubing with the lower-pressure reservoir being produced through the annulus.

Workover of the upper zone of a single-tubing, two-packer dual requires that the tubing and packers be removed from the well. The lower reservoir may be reworked by either the concentric tubing, dump bailer plugback, or wireline permanent completion method. Wireline workover of the

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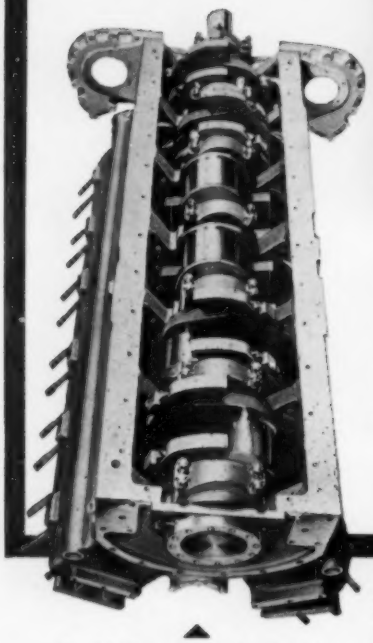
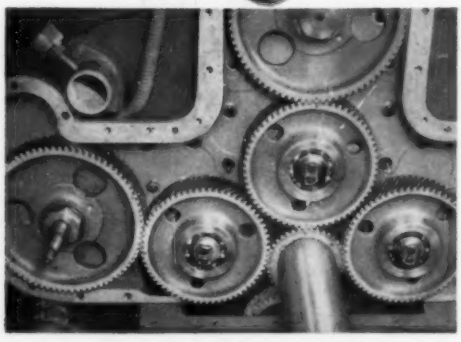


Crankshaft and main bearings in place in a typical Waukesha V-12 oil field engine. Note heavy flanges, thick bearing webs, rugged long-life construction.

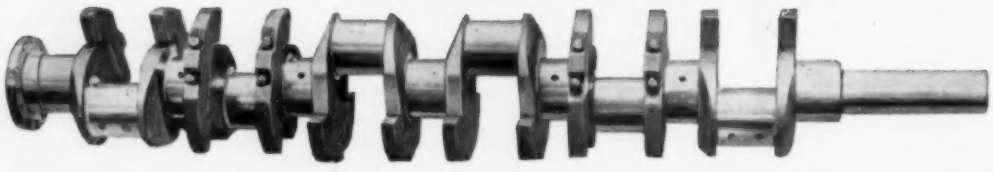
Precision-built and balanced rod assemblies, matched with pistons. Pressure oiled, mirror smooth, heavy pins. Replaceable bearing shells.

Removable wet cylinder sleeves of close-grained alloy iron, finished for oil retention and long life. Heavy duty, aluminum alloy, oil-cooled pistons.



Wide-faced helical cut timing gears are flood oiled. Materials selected for long, quiet life and accuracy. Gears and all elements in the power train, from pistons to flywheel, are precision-machined in Waukesha shops under Waukesha Quality Control.

Rifle-drilled, drop-forged, heat-treated crankshafts, precision-ground to exacting Quality Control standards. Note extra large bearing areas. Statically and dynamically balanced.



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SEND FOR BULLETINS

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Factories: Waukesha, Wisconsin and Clinton, Iowa

CHOOSE FROM A COMPLETE LINE . . . Another reason why you get more value with Guiberson . . .

Sure, there's a difference!

Dress your swab with genuine Guiberson cups and see for yourself.

You wouldn't wear a tux in a ball game, or overalls at a formal dance — and, for successful swabbing, it's more important that your swab be correctly dressed to suit the conditions. Guiberson, and only Guiberson, offers a selection from nine types of cups and suitable swabs in sizes ranging from 1" through 13⅜".

In most tubing swab jobs, one of three types of well-proved, service-certified Guiberson cups will give superb performance.

Type J

Flexible, strongly reinforced for repeated runs under heavy loads in deep wells.

Type L

More flexible, for medium or heavy loads in wells of any depth.

Type GW

Even more flexible, for light to medium loads in shallow wells, stripping light loads in wells of any depth, and for use in rough or deformed pipe.

Swabbing in oil, water, or acid-water, these cups last and last and lift fluid at a rate that assures a profitable operation. It stands to reason that, with the many variables possible in swabbing, no single type of cup or swab can give maximum performance under all conditions. If you have a special problem, your Guiberson representative will gladly recommend the combination of cups and swab best suited for your particular situation. Supporting his selection is the experience and integrity of the first and foremost swab manufacturer in the world.

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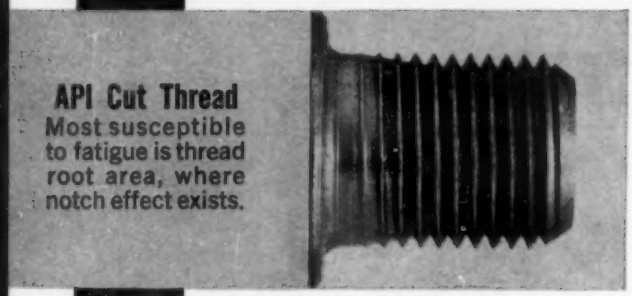
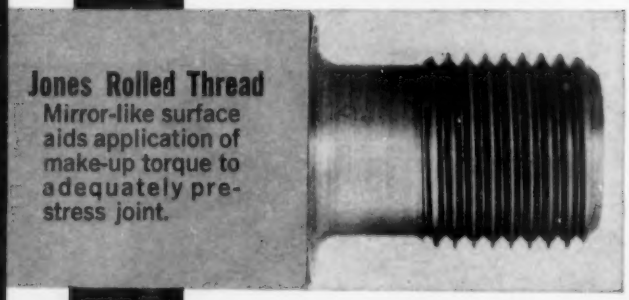
Rolled-Thread Undercut Pin

Greater Strength–Easier Make-Up



API Cut Thread
Most susceptible to fatigue is thread root area, where notch effect exists.



Jones Rolled Thread
Mirror-like surface aids application of make-up torque to adequately pre-stress joint.

Rolled threads, made by cold working or displacing the metal into the thread form, are stronger at the very point where most cut-thread pin failures originate. Steel fibers and grain are rearranged to follow the thread contour, providing a dense structure at the critical thread root . . . added strength where it is needed most. Additional fatigue resistance is obtained by undercutting the pin shank, thereby eliminating the run-out thread and improving the elasticity of the joint. The superior finish and gauge tolerances attained in Jones rolled-thread sucker rod pins reduce friction and make possible greater prestressing of the joint with equal torque.

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JONES
SUCKER RODS

TUBINGLESS COMPLETION

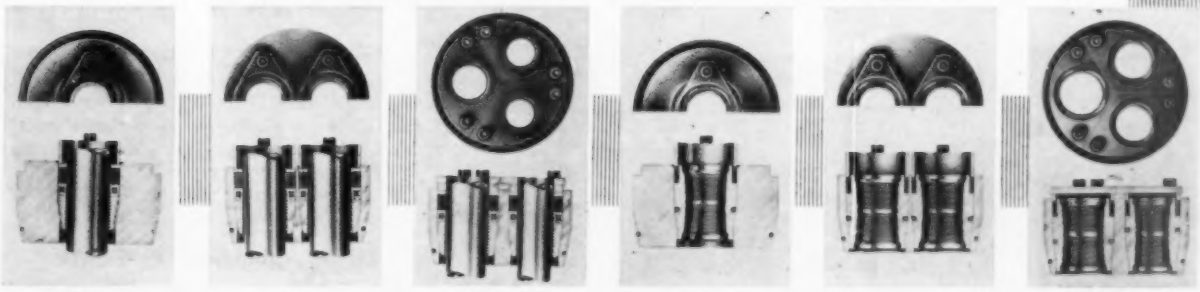
WITH

GULFCO'S CYC CASING HEAD

PROVED IN THE FIELD!

Gulfco planning and engineering have produced another first —a major step forward in economy and efficiency in modern completion methods. We at Gulfco are proud of the impressive record this CYC casinghead has already compiled in the field, and we invite your inquiry.

6 COMPLETIONS FROM 1 HEAD!



SINGLE WITH SLIPS | DUAL WITH SLIPS | TRIPLE WITH SLIPS | SINGLE WITH MANDREL | DUAL WITH MANDREL | TRIPLE WITH MANDREL

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GULF COAST MACHINE & SUPPLY COMPANY

lower zone can be performed by retrieving the straight or crossover flow choke by wireline and installing a tubing extension assembly of the required length (Fig. 11C). A concentric bypass assembly is installed below the extension hanger to seal the ports in the crossover flow assembly, thus isolating the interval between packers from the circulating system. With the exception of the bypass tool, wireline equipment and techniques for workover of the lower completion in this type dual well are the same as for reworking a single completion containing a packer.

Parallel-Tubing, Single-Packer

Parallel-tubing strings are used in a single-packer dual installation primarily to permit independent artificial lift of both completions (Fig. 12A). Wireline tubing extension or concentric tubing can be employed to wash sand from the upper zone, but both tubing strings must be removed for squeeze-cementing of this interval. Workover of the lower zone is accomplished in the same manner as previously described for the single-tubing, single-packer dual completion.

Parallel-Tubing, Two-Packer

The basic reasons for utilizing two packers in a parallel-tubing dual completion are (1) to avoid exposing the casing annulus to sand-laden or corrosive well fluids or to abnormal pressures, (2) to provide a means of gas-lifting both zones from a common gas source in the annulus, and (3) to permit wireline workover of intervals below the lower packer without exposing upper intervals to circulating fluids and squeeze pressures (Fig. 12B). In addition, this type installation affords a means of independent artificial lift of both intervals by rod pumps or subsurface hydraulic pumps.

To squeeze-cement the upper zone of a parallel-tubing, two-packer dual completion, it is necessary that the tubing and packer be pulled from the well. However, a tubing extension can be utilized on the upper interval for washing sand or for placement of acids or other chemicals to stimulate the formation. The lower interval can be reworked with wireline permanent completion methods in a manner identical to a single completion containing a packer because the casing-tubing annulus is completely isolated from the upper reservoir. Similarly, other through-tubing workover methods can be employed as in a single completion.

Triple and Quadruple Completions

Equipment and techniques utilized in triple and quadruple completions[15] are merely adaptations of dual completion methods. A triple completion can be made by installing two tubing strings and two packers with production from the two lower intervals being taken through the tubing and the upper interval being produced through the casing-tubing annulus (Fig. 13A). Where desired, the installation can be made to receive three tubing strings and three packers to isolate the casing from produced fluid or to facilitate independent artificial lift of all three intervals (Fig. 13B). Similarly, quadruple completions may be installed with either three or four tubing strings and packers, depending upon whether or not it is desired to produce all reservoirs through tubing and the artificial-lift requirements (Fig. 14).

As in the case of dual completions, it is common practice to independently and successively run the multiple tubing strings in the well. Normally, all packers are run on the first string, and other tubing strings are inserted into packer bores with a stinger arrangement for seating and sealing. Because of difficulties in inserting the last string of tubing in recent triple and quadruple completions, several operators have initiated the practice of running the packers and all tubing strings simultaneously through use of special blowout preventers and multiple-bore slips and elevators.

TUBINGLESS COMPLETIONS

Developments in completion technology during the past several years have made it practical under present producing conditions to employ conventional tubing as casing. The tubingless completion is a significant step forward in engineering well equipment to fit producing requirements. The long experience in utilizing tubing as the production string in conventional single and dual wells coupled with the more recent experience with tubingless completions themselves has established that the smaller, realistically sized completions are adequate for the producing rates in most domestic wells.

Both wireline and concentric tubing completion and workover methods are adaptable to the tubingless completion and have been used with a high degree of success. The plastic sand consolidation method for sand control is especially attractive in eliminating the need for small pipe as an inside screen. Well control and production techniques permit efficient well operation on single and multiple completions made with small-diameter casing.[16]

Single Tubingless Completion

The single tubingless completion is essentially a scaled-down version of a conventionally sized well except that the inside tubing string may be eliminated in many wells.[17] Equipment used in this type completion is the same as for larger wells, including a float collar, guide shoe, and other casing cementing equipment (Fig. 15). Landing nipples, used widely in the tubing of conventional wells, may be installed in a casing string at predetermined depths to facilitate well control and workover operations.

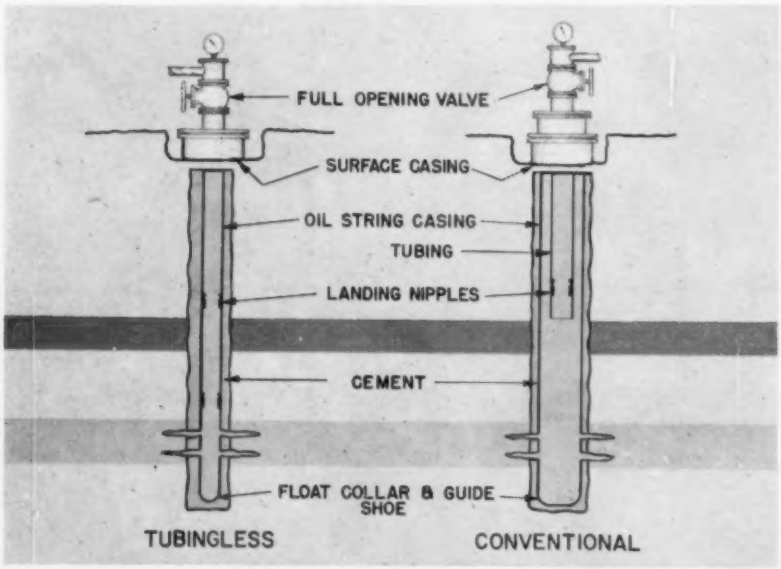


FIG. 15. Single tubingless completion is in effect a scaled-down version of a conventional completion in which the standard inside tubing string has been eliminated.

Better Production Tools Through Research

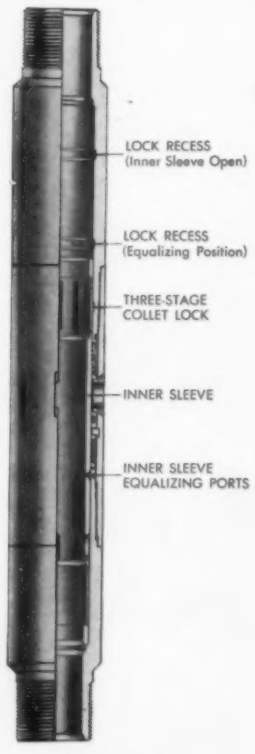
OTIS Equipment NEWS

Volume III, Number 1 **Otis Engineering Corporation • Dallas** *Production Equipment and Services*

Otis Sliding Side-Door Proves Most Versatile Circulating and Production Tool in the Field Today

Three Different Versions Solve Many Costly Production Problems

DALLAS — The Type A Otis Sliding Side-Door®, designed and introduced to the oil industry just four years ago, has become the most widely used selective circulating and production tool in the field today. Since its introduction, two modified versions — the Sliding Side-Door, with pump-out plugs and expendable shifting device, and the Sliding Side-Door Cross-Over — have been introduced.



TYPE A OTIS
SLIDING SIDE DOOR

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The Type A Otis Sliding Side-Door is a full-opening tool designed to provide a selective means of establishing a flow course between the tubing and annulus without killing the well, moving the tubing, or disturbing the packer setting. The tool is opened or closed by standard wire line methods and so designed as to permit any number of Sliding Side-Doors to be installed in a single string of tubing and any one or all opened or closed with a single run of the rugged, proven shifting tool. The Sliding Side-Door with pressure shifting tool may be run in on the tubing in the opened position and after circulating may be closed by pumping down an aluminum ball or drop plug.

Proven Design Features

According to the many operators using this equipment, there is an exclusive combination of features that makes the Otis Sliding Side-Door preferable for efficient well completion and economical production. These are: (1) Thoroughly proven in thousands of wells. The design and mechanical operation of the tool has several years of operating proof behind it — the producer can use the Otis Sliding Side-Door with confidence. (2) Positive indication of opened-closed sleeve position. The shifting of the inner sleeve of the Sliding Side-Door is accomplished by the rugged Otis Shifting Tool. This proven Otis Shifting Tool is an automatic self-releasing device that serves to indicate positive opening or closure of the sleeve. The inner sleeve also incorporates equalizing ports that are designed to permit equalization of abnormal pressure differentials when shifting the sleeve. (3) Outer sleeve design and construction combined with the clearance between the inner and outer sleeves have practically eliminated the metal-to-metal bind that makes shifting other tools often impossible. The Type A Otis Sliding Side-Door is designed to withstand the distortion forces of temperature, compression, tension, or torque and still be shifted. (4) Flow area through the sleeves of the Otis Sliding Side-Door is of ample size to permit desired fluid passage.

Versions for Special Application

The Type A Otis Sliding Side-Door with pump-out plugs and an expendable pressure shifting device provides additional blowout protection and cuts completion costs. This version of the Otis Sliding Side-Door permits the tree to be nippled up and drillable packers to be tested before unloading the well.

Another version is the Otis Sliding Side-Door Cross-Over which is designed to provide complete zone isolation while changing or removing cross-over chokes in single-string, dual completions.

All three Otis Sliding Side-Doors are available in a wide range of sizes — and all three Sliding Side-Doors are good examples of the cooperation of Otis' Well Completion Specialists and Engineering Staff in assisting operators to meet today's demand for economical well completion and production tools. Literally thousands of production problems have been solved by Otis over the past thirty years. Perhaps you are faced with a production problem Otis could help solve. If so, call your local Otis specialist today. For more information on Otis Sliding Side-Door equipment, call the Otis office nearest you or write Otis, Dept. E-1, P. O. Box 35206, Dallas 35, Texas. You'll find experienced Otis Well Completion Specialists ready to help you . . . anxious to serve you . . . and with the widest variety of field proven production equipment and services available today.

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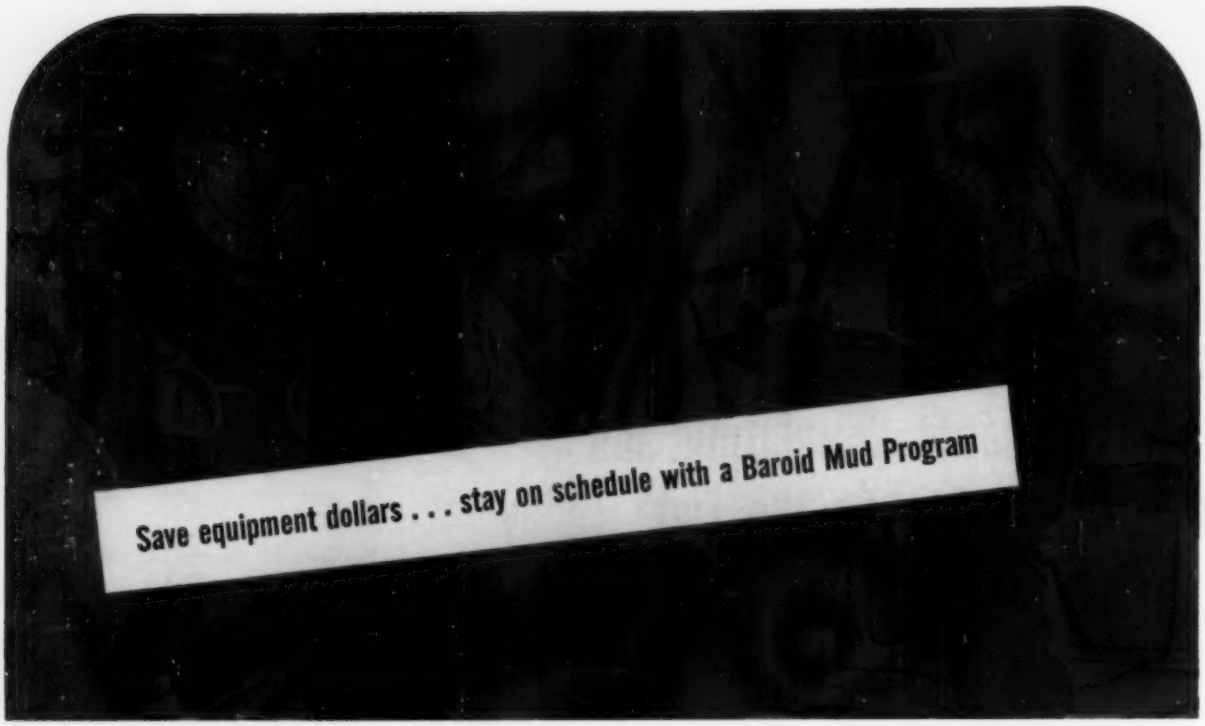

Baroid Field Report: Cass County, Texas

X-COR* solves drill pipe corrosion problem

Baroid's new film-forming corrosion inhibitor X-COR was proved again by successfully controlling drill-stem corrosion caused by hydrogen sulfide gas from the Smackover Lime formation in Cass County, Texas.

The Smackover Lime is an oil productive zone, but its corrosive sulfides severely attack drill pipe. In Cass County, pilot tests warned when the Smackover Lime formation was being entered at 11,000 feet. A slug treatment of only 2 lb/bbl X-COR was added through the pump suction and drilling proceeded to total depth of 11,200'. The flow properties of the drilling fluid remained unchanged, and the drill pipe came out of the hole free from attack by corrosion.

X-COR produces a tenacious waterproof film that protects down-hole equipment and seals the hole wall and cuttings against hydration, especially important in drilling shale formations. X-COR also serves effectively in packer fluids to ward off corrosion by fluids left in the casing/tubing annulus. X-COR inhibits corrosion caused by hydrogen sulfide gas, oxidation and electrolytes. Easy and safe to use, X-COR does not fluoresce, does not significantly change mud properties and is compatible with all commonly used water-base mud systems.

X-COR demonstrates again that Baroid's new customer-oriented program of research and marketing saves you money. For full details on X-COR, write for free data sheet.

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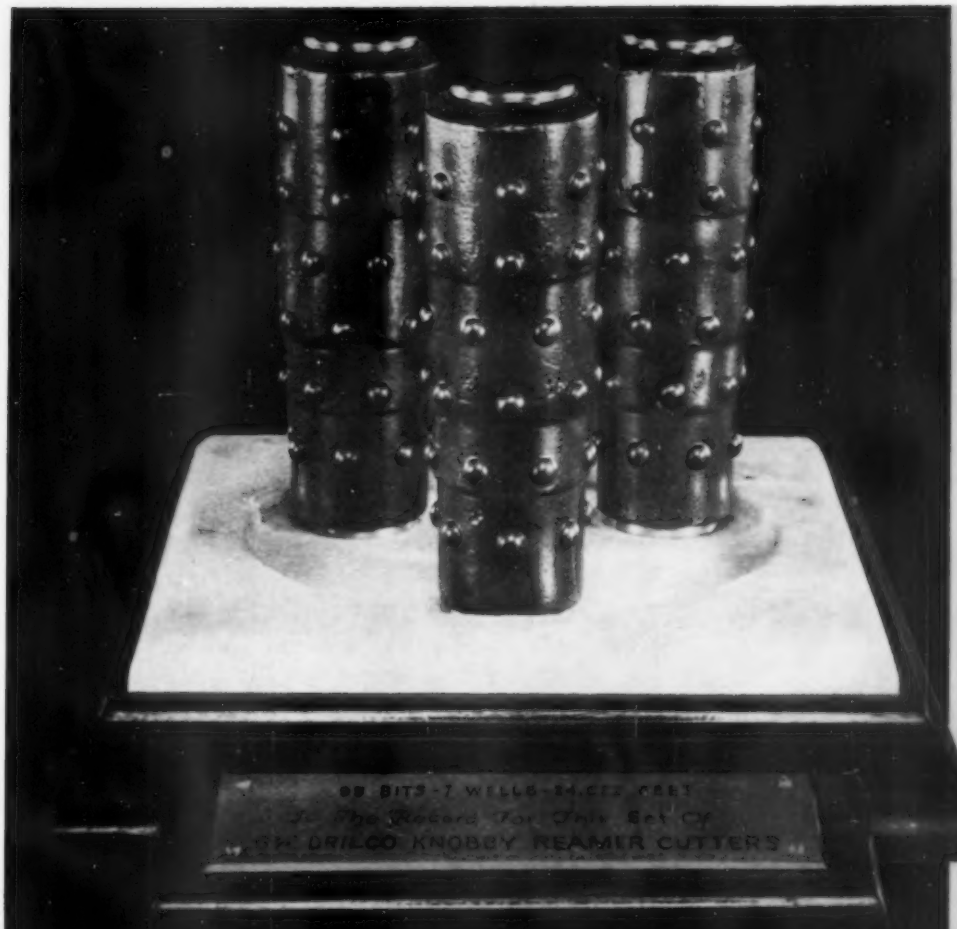

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Preserved for oil industry history, the above set of 6-¾" Drilco Knobby Reamer cutters compiled the tremendous record of reaming 24,622 feet of hole in seven wells.

They assured a full gage hole for 99 rock bits during a period from December 1959 to April 1960 for Dual Drilling Company's Rig #2 and Rig #6 in wells drilled in Crane and Pecos County, Texas, and Lea County, New Mexico.*

Reamer costs were cut 50% and reaming to the bottom with a new rock bit was eliminated. Performance like this has made the Drilco Knobby Reamer a sensational money-saver in terms of maximum performance at minimum cost, while assuring the user of NO undergage hole problems.

You, too, can solve your undergage hole problems with Drilco Knobby Reamers. Call your nearest Drilco representative.

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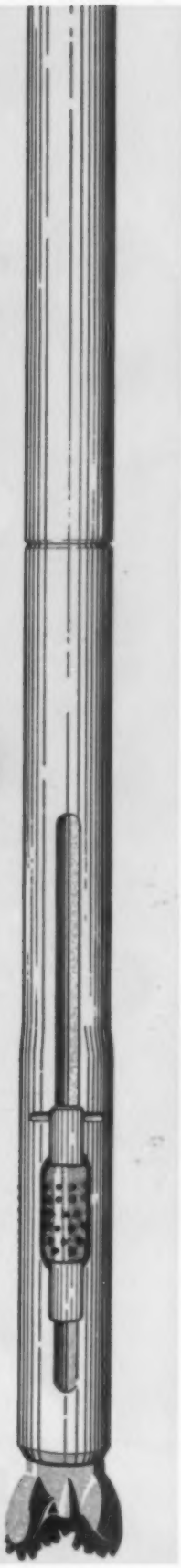

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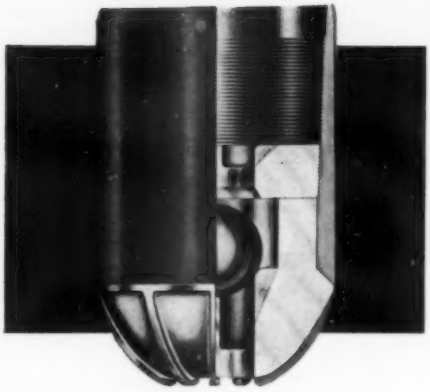

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The ribbed aluminum guide nose on RECTOR'S Type "A" float shoe is your best bet for getting pipe safely "on bottom" every time. Made from a special aluminum alloy, developed by RECTOR, it provides far greater impact, compression, tensile and shear strength than either concrete or bakelite. RECTOR'S aluminum guide nose guides the cementing shoe past ledges, bridges and other obstructions without danger of breaking. On completion, the aluminum alloy can be drilled out easily, and because there is less material to drill out, it drills out faster.

This superior feature is yours at no extra cost . . . So, for dependability, and exacting performance in all cementing operations, put your money on a sure winner. Specify RECTOR Type "A" cementing equipment from your favorite supply store or see your RECTOR representative.

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. . . prevents paraffin accumulation

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SOLVO® Paraffin Remover corrects by preventing

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What SOLVO is

SOLVO Paraffin Removers are organic liquids, dispersible in both oil and water. They contain no carbon bisulfide or carbon tetrachloride and are essentially chloride-free. This is important to the refiner. SOLVO Paraffin Removers are safe to use because they have high flash points, low vapor pressures.

Ask your Tretolite field service engineer (the "Man in the Red Car") for more facts and figures on SOLVO-preventive maintenance in *your* wells.

TPR-60-2

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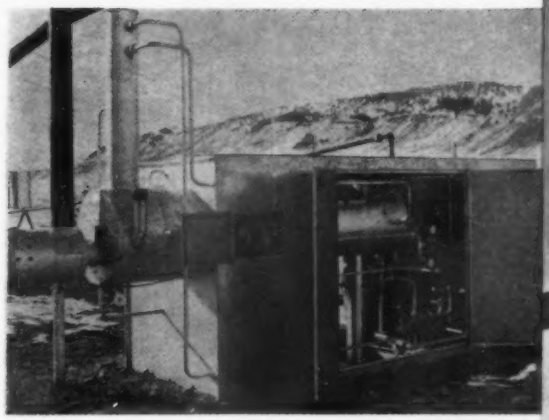
This ESKIMO Dehydrator is located in the Big Piney Field, Western Wyoming.

DEHYDRATION

till Hell freezes over



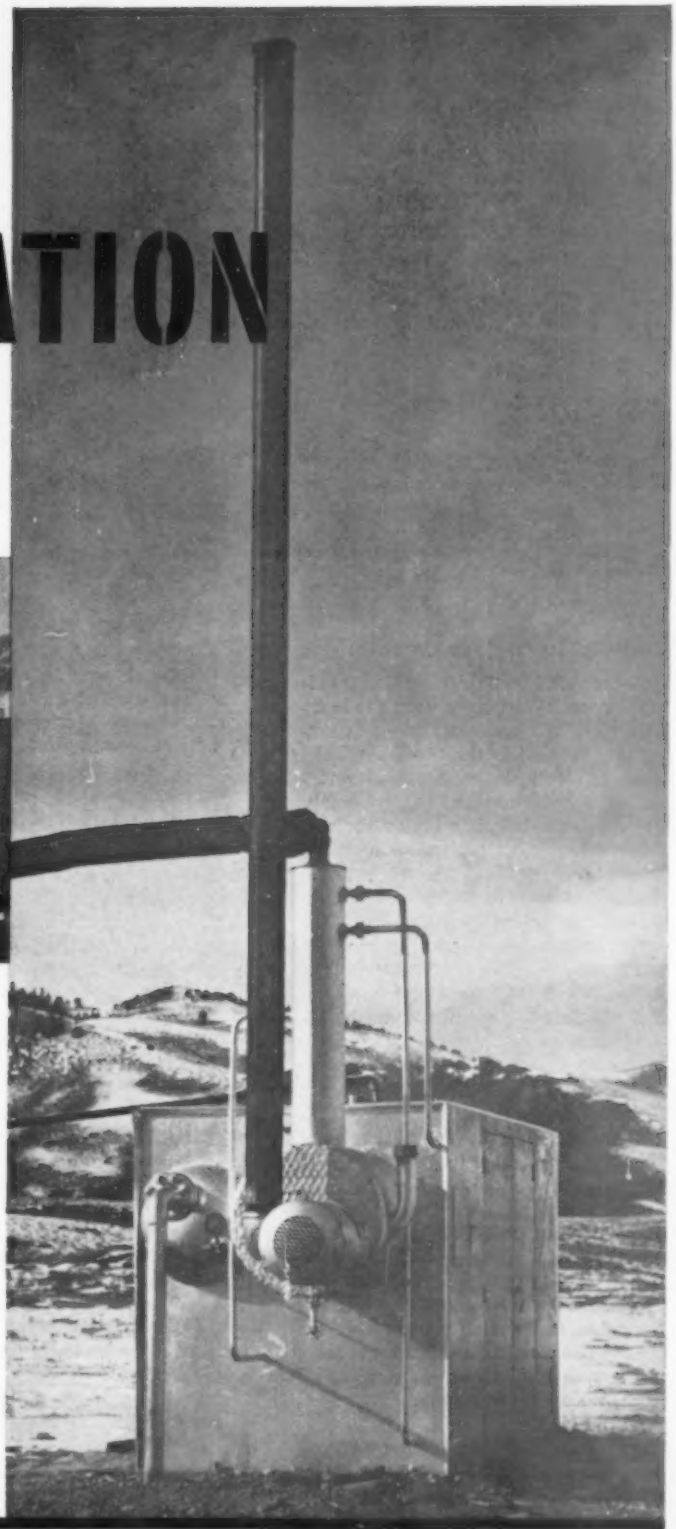
with ESKIMO

The ESKIMO — BS&B's Economy Glycol Dehydrator — is a self-contained unit, housed and protected against extremely low ambient temperatures.

This unit has 3-phase resolution of the well stream and 65° dewpoint depression of effluent gas. It is equipped with flame arrestors for maximum safety against fire hazards.

ESKIMO is available in 2 MMSCFD and 4 MMSCFD units with 2 or 3-phase integral scrubbers, and operates on an unattended basis.

Ask your BS&B man about ESKIMO or write to Black, Sivalls & Bryson, Inc., Dept.1-GY3 P. O. Box 1714, Oklahoma City, Oklahoma.



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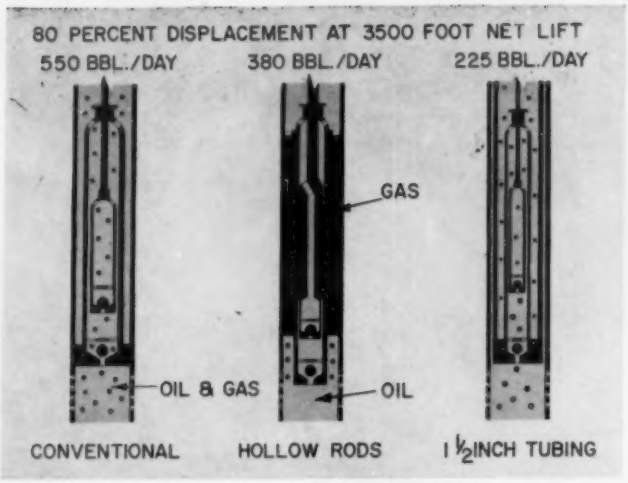

FIG. 16. Sucker-rod pumping of tubingless completions can be accomplished with small pumps and sucker rods or with small hollow rods. The hollow-rod completion can be used to produce oil through the rod, or to produce oil up the annulus and gas through the rod.

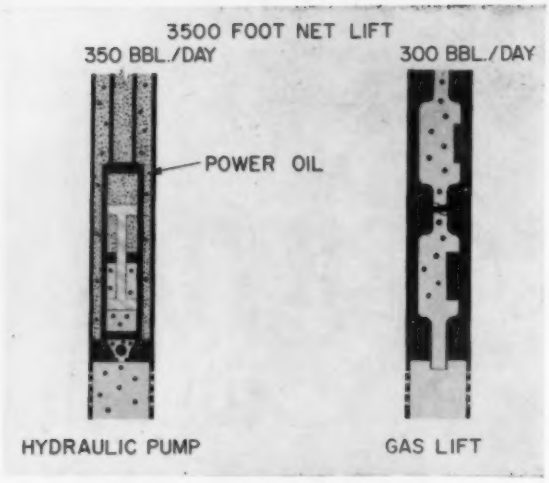

FIG. 17. Rodless pumping methods adaptable to tubingless completions include a small hydraulic pump and gas lift.

Multiple Tubingless Completions

A number of dual, triple and quadruple completions have been made by cementing conventional tubing as casing side by side in the same borehole. This type completion provides versatility in completion and workover operations in addition to important cost reductions. Early multiple tubingless completions were made by running clamped strings of casing with prepositioned orienting mandrels in the upper casing strings for directionally perforating.[18] A mechanical orienting device, which utilizes a spring-loaded arm attached to the directional perforator to orient with the maximum eccentricity of the mandrel, is used to direct the perforator charges in the proper direction.

More recently, directional perforating devices have become available which do not require preplaced mechanical devices in the casing for oriented perforating. The devices have permitted casing strings of multiple completions to be run independently.[19] The original tool of this type utilizes a focused radioactive source which is rigidly attached to a directional gun. The source and gun are rotated with a ratchet mechanism operated by reciprocation of the wireline with 30 degrees of rotation obtained with each vertical pull. Orientation of the radioactive source, which is fixed in relation to the directional charges, is determined at the surface by a signal from a gamma-ray detector run on a wireline in an adjacent casing string.

Recently equipment was developed which provides gun orientation without use of a multiplicity of wirelines and without downhole mechanical devices. This device also operates on a radioactive principle, but the source and detector are rigidly attached to the perforating gun, permitting location of adjacent casing strings and positioning of the gun to fire in the desired direction with only one conductor line.

Artificial Lift

Artificial-lift methods long used on conventional completions have been adapted for tubingless completions. All commonly used artificial-lift techniques can be utilized on tubingless completions to accommodate a wide range of producing capacities and well conditions.

Three subsurface installation arrangements are available for sucker rod pumping (Fig. 16). Wells may be equipped with either 1¼-in. or 1½-in. tubing and small rod pumps with ½-in. sucker rods. Hollow sucker rod installations may also be employed with fluid being produced through the hollow rods and the isolated annulus filled with inhibited oil to minimize casing wear and corrosion. For wells which require a vent for gas production, hollow rods have been utilized with fluid being pumped up the annulus and gas being produced through the hollow rod. Full-size pumps on conventional rods have been employed to obtain increased lift capacity in wells which produce large volumes of water.

Other artificial-lift systems which may be used in tubingless completions are hydraulic subsurface pumps and gas lift (Fig. 17). Hydraulic subsurface pumps can be installed on small tubing in the conventional manner to lift relatively large volumes of fluid while providing a flow path for corrosion and paraffin inhibitors. Gas-lift installations can be made with small gas-lift valves on tubing installed inside the casing.

Workovers

Through-tubing completion and workover methods for conventional wells are applicable and are largely responsible for the increasing interest and utilization of the tubingless completion method. Landing nipples placed in the casing string at depths predetermined from logs may be utilized to permit installing a wireline retrievable plug for plugback or to recomplete lower by setting a pack-off sleeve across existing perforations (Fig. 18). A packoff sleeve utilizing slip-type hanger devices can be employed to seal casing leaks. These tools are designed to permit retrieving by wireline should it become desirable to re-enter old intervals for testing.

Low pressure squeeze-cementing can be accomplished with a small pulling unit and concentric tubing in the same manner as in conventional wells (Fig. 19). Small tubing can also be used to wash sand and to treat with plastic for sand control. Casing leaks resulting from rod wear, corrosion, or other reasons may be repaired by squeeze-cementing in the conventional manner.

Advances in stimulation by fracturing permit this type operation to be performed in tubingless completions with success comparable to that obtained in conventional completions. Fracturing at rates of approximately 10 bbl per min has been successful in tubingless completions and conventional wells in the West Texas and Southwest Texas areas when utilizing fracturing fluids designed to utilize more efficiently the energy available at

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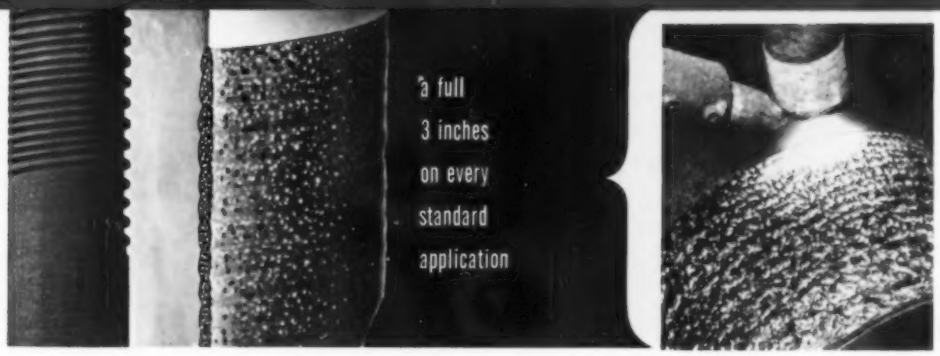

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Job — Clemile Savoy #1, Vermillion Parish, Louisiana

Owner — Continental Oil Company, Houston

Contractor: Dillard-Waltermire, Inc., Houston

Job #1 — 11,030′ of 9⅝″ O.D. casing cemented in 12¼″ hole with 1,000 bags neat UNAFLO cement. Slurry fillup behind casing 3,130′. Drilling mud wt. 11.5 lbs/gal. Schlumberger temp. log 168° F. Est. static BHT 193° F.

Job #2 — 1,298′ of 7″ O.D. liner set in 8⅜″ hole from 10,910′ to 12,208′, cemented with neat slurry 220 bags UNAFLO. Drilling mud wt. 16.2 lbs/gal. Schlumberger temp. log 196° F. Est. static BHT 226° F.

Job #3 — Squeezed top 7″ O.D. liner with 300 bags neat UNAFLO. Final pump truck pressure 2,000 psi.

Job #4 — Squeezed 150 bags Cealment (UNAFLO plus latex) through retainer set at 12,182′ into lost-circulation zone below 7″ O.D. liner.

Jobs #5, 6, 7 — Bradenhead squeeze jobs using 100 bags; 150 bags; 150 bags Cealment respectively into lost circulation zone at 12,350′. Final pressure 400 psi.

Job #8 — 2,725′ 4½″ O.D. liner set in 6″ hole from 12,017′ to 14,742′ cemented with 300 bags UNAFLO weighted (18 lbs/gal.) with HiDense #2 (Ilmenite Ore). Mud wt. 18.4 lbs/gal. Est. static BHT 284° F.

Job #9 — Full string of 7″ O.D. casing tied into top of 7″ O.D. liner at 10,910′, cemented with 50 bags neat UNAFLO.

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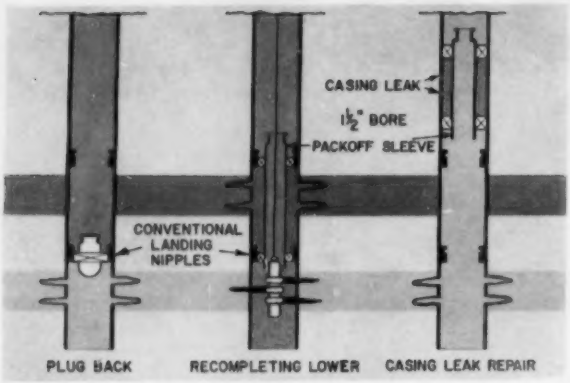

FIG. 18. Wireline workovers of tubingless completions are facilitated by placement of conventional landing nipples which permit such wireline work as plugging back a lower formation, recompleting a lower formation, and repairing casing leaks.

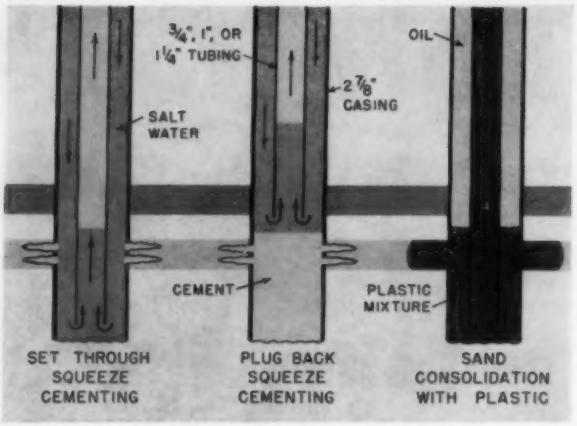

FIG. 19. Concentric tubing workovers of tubingless completions include such operations as squeeze cementing, plugging back, and consolidating sand with plastic.

the formation during injection. Additives are available to provide the required properties in customary fracturing fluids.

All of the techniques described for workovers can be employed on either single or multiple tubingless completions if an orienting device is used for upper-zone perforating in multiple wells. In multiple completion work, workover and servicing operations can be performed on one completion without disturbing production from adjacent completions.

One operator reported on the completion of 179 tubingless wells ranging in depth from 1400 to 12,000 ft in Texas, Louisiana, and Mississippi. These included 150 single, 16 dual, 11 triple, and 2 quadruple wells for a total of 223 completions. Average cost reduction for single wells with cost data available was 19% of conventional well costs. This cost reduction is attributed to use of reduced perforation density, minimum cost fracturing treatments and other economics which could have been applied to conventional wells as well as to savings in steel from miniaturization. Other operators have reported savings of the same magnitude.

NEEDED DEVELOPMENTS

The current economic pressure on the petroleum industry presents a challenge, especially to technical personnel, to devise methods which will permit the continued development of domestic oil and gas reserves with a reasonable return on investments.[20] One of the most important avenues for providing efficient means for producing regulated allowables lies in the realistic sizing of all oil field equipment. Although available methods permit efficient well completion and operation and provide attractive savings, accelerated development of equipment specifically designed for small-diameter wells is required to fully exploit this completion procedure.

Operators report little reduction in the cost of actually drilling tubingless wells over the cost of drilling conventional wells because of inferior smaller size bits and the general limited availability of rig equipment designed to capitalize on the advantages of small-hole drilling. A more efficient bit or cutting mechanism is needed that will drill holes as small at 4¾-in. at a rate commensurate with the reduced excavation required. Development of a satisfactory small-diameter bit would provide additional incentive for the development of small, highly portable drilling rigs and associated equipment with emphasis on automatic operation.

Developments are also needed for artifical lift of both conventional and tubingless multiple completions. Current practice is to employ a multiplicity of surface installations to artificially lift from conduits which are spaced less than 6 in. apart. A promising approach to this problem is a hydraulic subsurface pumping system in which the paraffin or solids content and the lubricating characteristics of the power fluid are not critical. Development of a small, electrically driven subsurface pump and conductor system to minimize downtime for service and eliminate the necessity for auxiliary tubing strings, would prove particularly attractive.

For workovers, the incentive and need exists for equipment especially designed for small-diameter wells with emphasis on increased automation. Highly portable unitized units which contain hoists, masts, low-volume, high-pressure pumps and all other necessary equipment would provide increased efficiency and lower cost of operation. With properly designed equipment, development of a new cementing material which would provide sufficient strength with only 2 to 3 hours' waiting time would complete the "package" of workover procedures and provide a 1-day operation for all types of through-tubing workovers.

The responsibility of the petroleum engineer resides primarily in devising methods for insuring satisfactory return on investments. Although significant strides in completion technology have been realized in the past, the need for even more drastic and revolutionary developments remains a challenge to the petroleum engineer in maintaining a healthy profit level of the domestic oil and gas industry.

References for Part 10B

10. Turner, Marshall C.: "Dual Completion Equipment and Practices," API Mid-Continent District Spring Meeting, Oklahoma City, Oklahoma, March 17-19, 1954.
11. Miller, E. B. Jr.: "A Survey of Dual Completions," API 27th Annual Meeting, Chicago, Illinois, November 11, 1947.
12. Alcorn, I. W., and Alexander, W. A.: "A Review of Multiple-Zone Well Completions," API 23rd Annual Meeting, Chicago, Illinois, November 10, 1942.
13. Prutzman, F. G.: "Economics Fosters Dual Completions," API Southwestern District Spring Meeting, Fort Worth, Texas, March 21-23, 1956.
14. Tausch, G. H., and Kenneday, John W.: "Permanent-Type Dual Completions," API Southern District Spring Meeting, San Antonio, Texas, March 7-9, 1956.
15. Poimboeuf, Walter W. Jr., and Cieply, William W.: "Multiple Completions Offshore," API Southern District Spring Meeting, New Orleans, Louisiana, March 25-27, 1959.
16. Corley, C. B. Jr., and Rike, J. L.: "Tubingless Completions," API Southern District Spring Meeting, New Orleans, Louisiana, March 25-27, 1959.
17. Stekoll, M. H., and Hodges, W. L.: "Use of Small-Diameter Casing Reduces Well Costs," *World Oil* (February 1, 1959) Vol. 148, No. 2, p. 70.
18. Corley and Rike, *op. cit.*
19. True, Martin E., and Corley, C. B., Jr.: "Mechanical Aspects of Tubingless Completions," ASME Petroleum Mechanical Engineering Conference, Houston, Texas, September 20-23, 1959.
20. Pistole, Harry, and True, Martin E.: "Today's Economy — A Challenge to the Operators and Designers of Oil Field Equipment," ASME 13th Annual Petroleum Mechanical Engineering Conference, Denver, Colorado, September 21-24, 1958.

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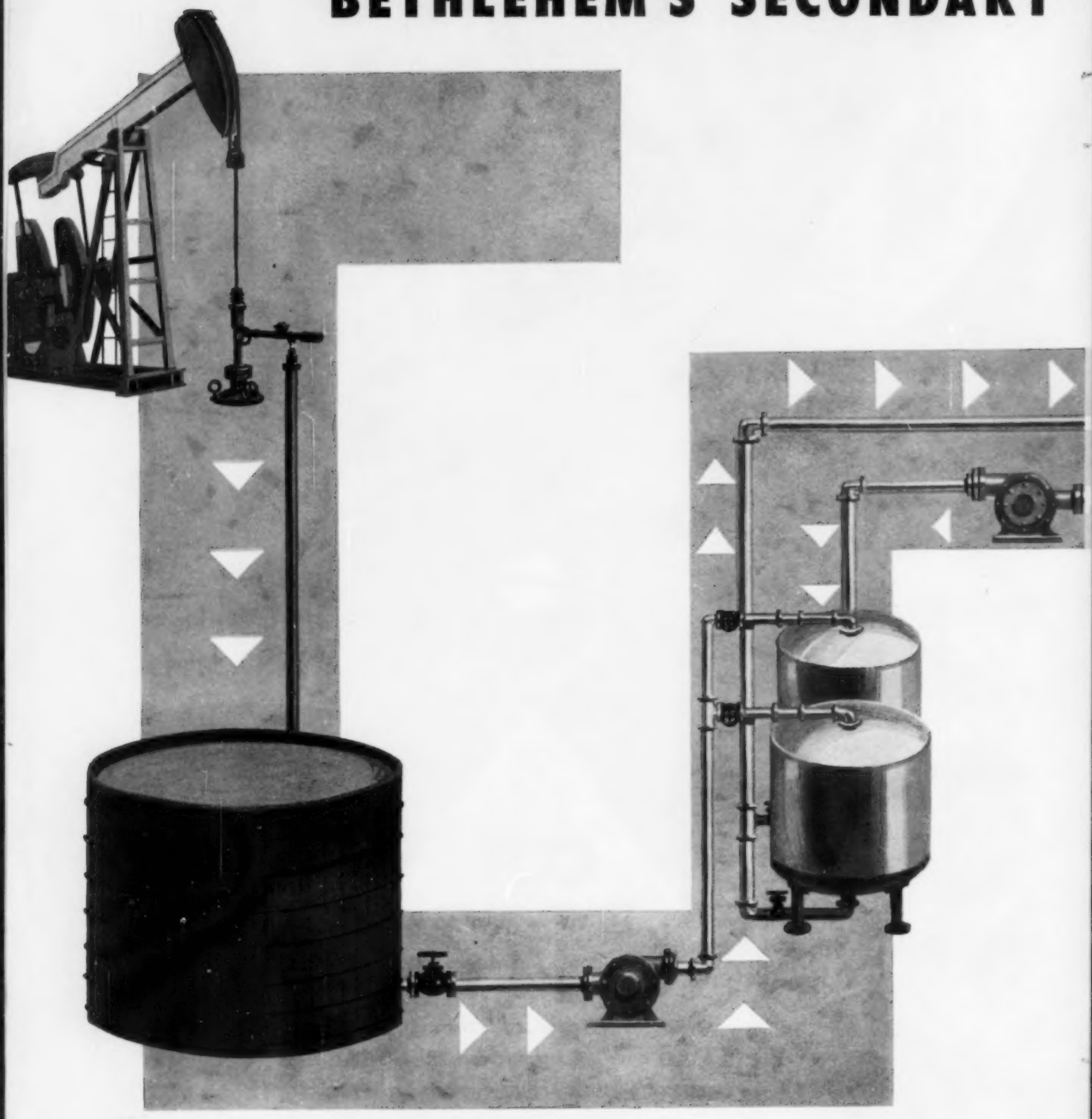

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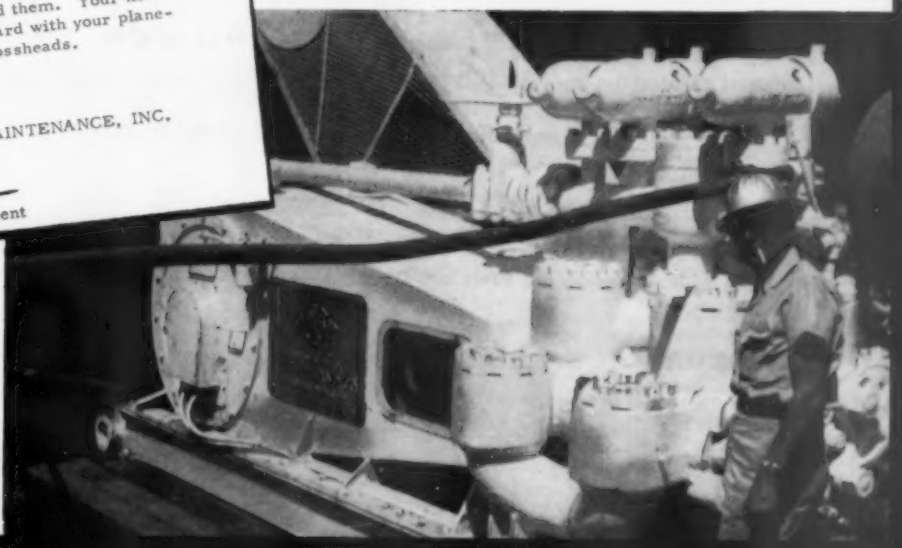

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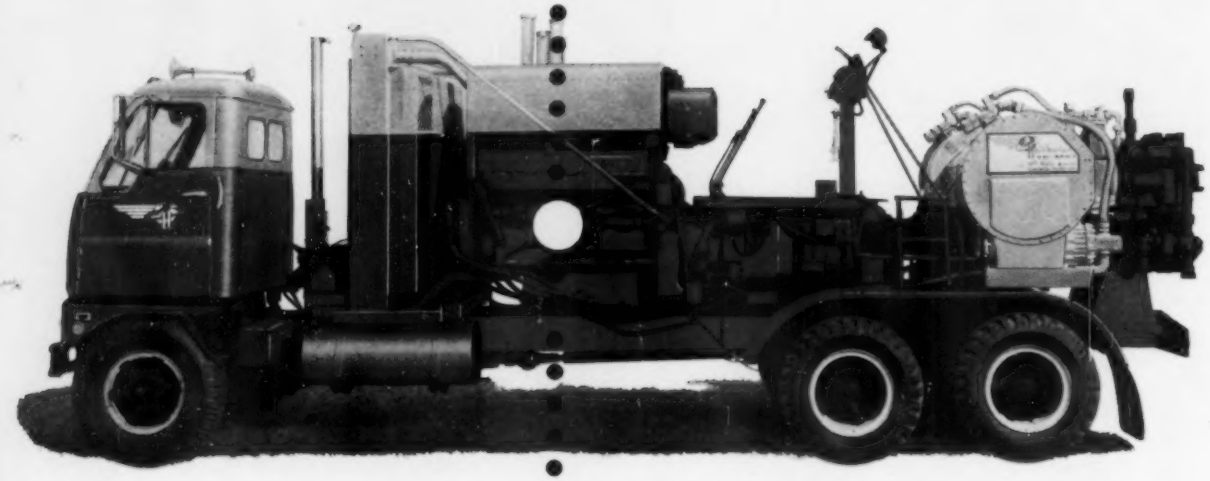

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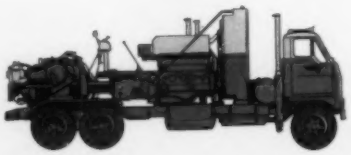

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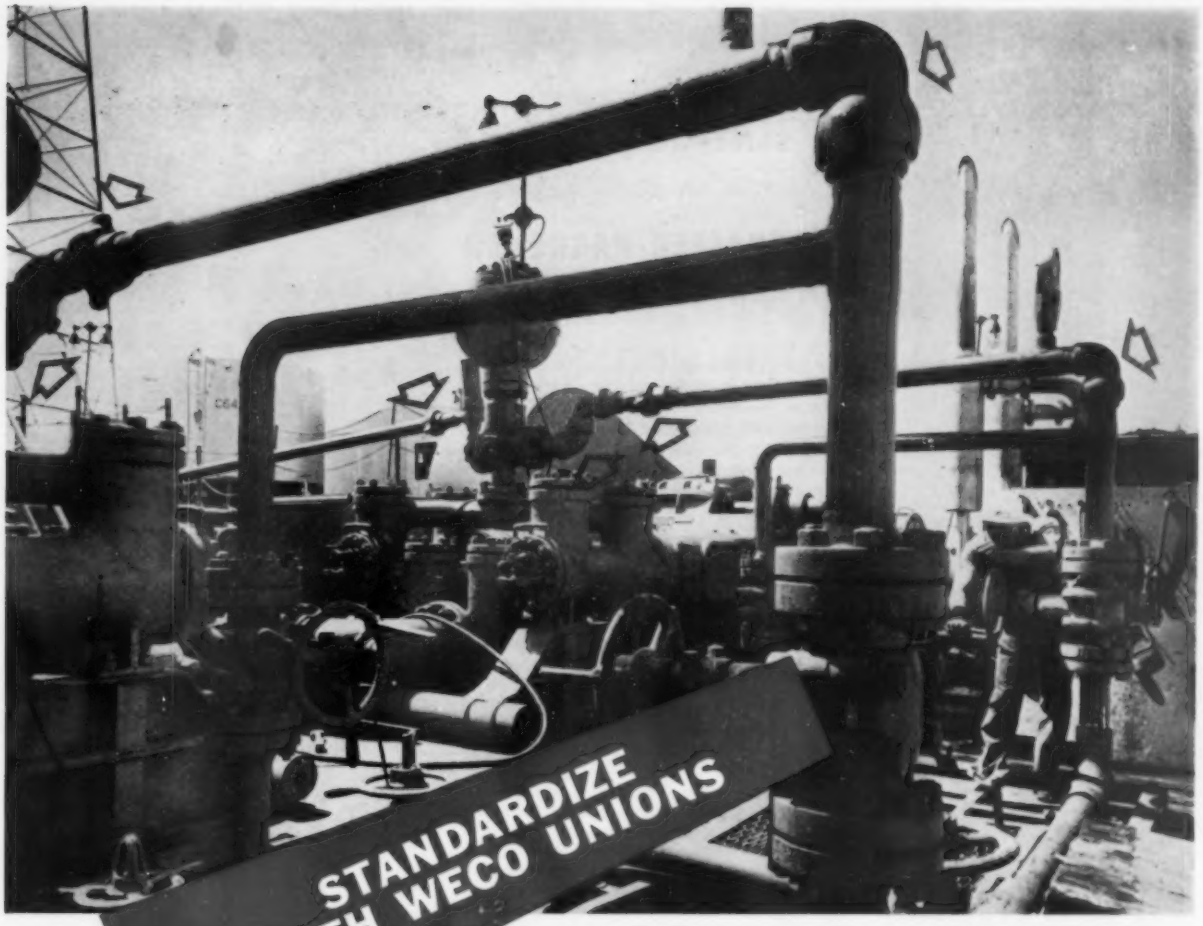

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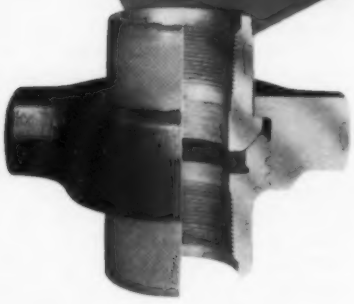

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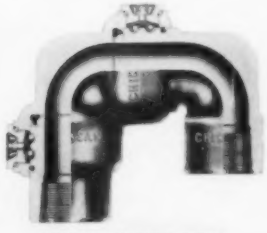

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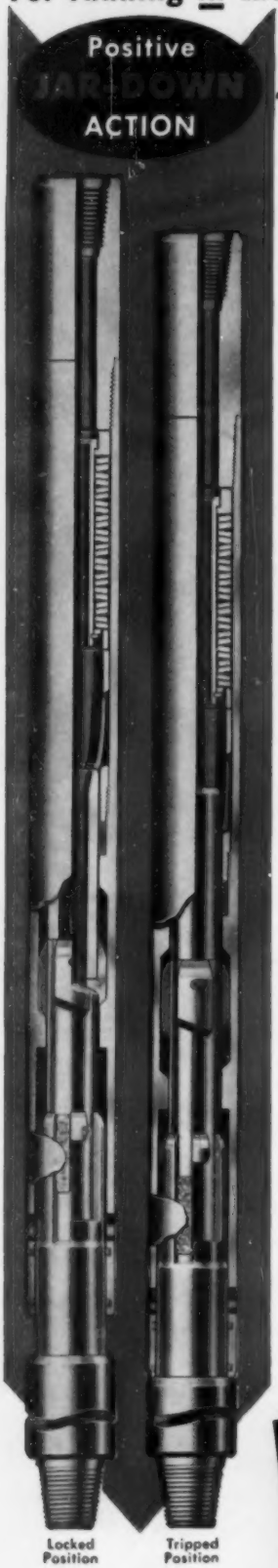


See the Shaffer section of your Composite Catalog.

THE SHAFFER-WAGGENER BUMPER SAFETY JOINT

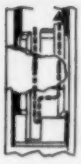
There is no other tool like the Shaffer-Waggener Bumper Safety Joint. It combines—in ONE tool—a choice of *jar-down* and *releasing* actions, both under complete control of the operator. What's more, the tool is so rugged it is run as part of the drill string to protect against stuck pipe.

In actual well service it has operated easily at depths below 18,000 feet, and has given no operating problems even in directionally-drilled wells with extreme slant.

Jar-Down Action

▶ **RUN IT IN THE DRILL STRING**—It is specifically designed to withstand the continuous vibration and heavy torque loads of today's drilling operations.

▶ **TO JAR DOWN** whenever the drill pipe threatens to stick—or to drive drill collars out of keyseats and to free 'balled-up" bits—simply slack off weight equivalent to about 2,000 feet of drill pipe onto the tool. This releases the tripping mechanism, automatically striking a sharp down blow. Raising the string automatically re-sets the tool for another blow—and blows can be struck repeatedly as fast as the string can be raised and lowered. And no torque or twisting strains are placed in string!



Releasing Action

▶ **TO RELEASE,** in the event jarring will not loosen the stuck string, simply trip the tool and apply reverse torque as the string is slowly raised. Only one-sixth turn of the tool rotates the drive keys into unlocking slots so that complete release is effected by continuing to raise the string.

ANOTHER ADVANTAGE—the tool transmits full torque loads in *either* direction through three rugged drive keys—not through easily-damaged threads. It is the strongest joint in the string—not the weakest, as with conventional safety joints.

Also, the tool can be re-connected again by simply lowering the top portion over the lower portion and reversing the releasing action. It is ideal for use in fishing strings!

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

38 YEARS OF OIL TOOL LEADERSHIP

THE THREE P's IN WELL SERVICING TODAY

Problems . . . Profits . . . Progress . . . three of the most significant topics before the recently-concluded 5th Annual Convention of the Association of Oilwell Servicing Contractors . . . are frankly and openly discussed by AOSC's past president

Problems

The average well servicing contractor's problem is simple: there just isn't enough work. The soaring sixties just aren't soaring at a pace to which some of us have been expanding our operations. This may well be the year of survival for many of us.

What causes this problem? For one thing, most of us are without formalized education, analytical type minds, and believe ourselves to be much more competent than our accountants, CPA's and financial advisors who would have never expanded so rapidly without basic, justifiable reasons. The boom came, drilling flourished and we all wanted to get our share. This problem is not a new one. Part of it has been created by well meaning customers. Some by field conditions, a few by manufacturers and suppliers. But, the big problem was brought upon the contractor by himself.

Estimates of future demands for our service are difficult to appraise because they are geared directly to where the producer will receive his best return. Indications are that 1961 will show only a small increase in production, development and exploration drill-

JAMES W. WILKINS,
D & J Services, Inc.,
Andrews, Texas

ing over 1960. So, barring outside influence, political pressure or another Suez, the producing segment, from which we receive our work, will show little change for 1961 in the opinion of the experts.

This is the problem, and problems can be solved only by first recognizing them and then attempting their solution. This may mean that some servicing contractors may go out of business . . . while others will show good growth and possible expansion. Our only gage of success in this highly competitive business is profit.

Profit

For too many contractors, the word "profit" has been a seldom-used word in the past few years. Survival has superceded profit. What can we do to increase our profit position?

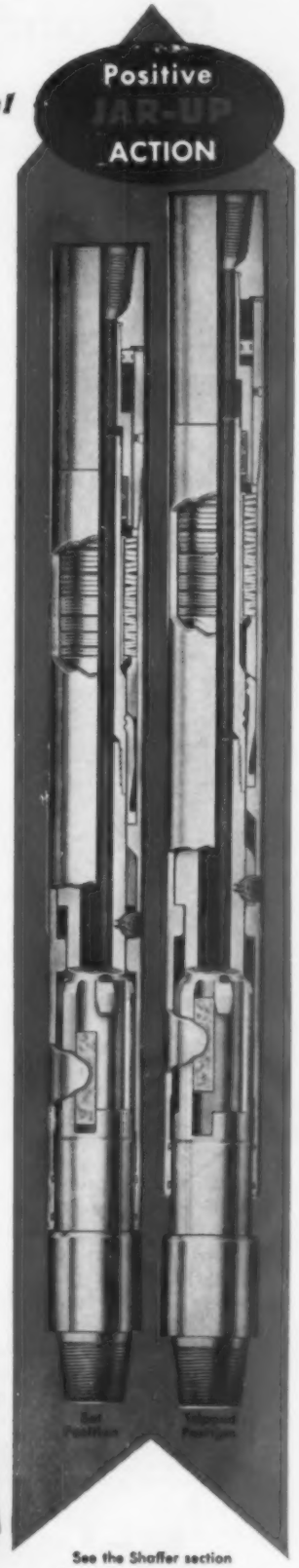
1. Continue to give the producer the best service available for his servicing dollar. AOSC programs and projects are dedicated toward assisting members to accomplish this objective. We must, as an association, continue to improve and upgrade our members as good businessmen, which means the utmost in service to the customers, and the right then to expect a profit. We must make the customer realize that one cannot get something for nothing (since there is no such thing) and only the customer will eventually pay the cost. We should work through the association to broaden our understanding of field and business problems and to generate new ideas and profit from the experience of others.

2. Accept the fact that to survive we must properly apply men, money, and

For fishing, testing and core-drilling strings . . .

. . . plus Safety Joint protection!

Positive JAR-UP ACTION



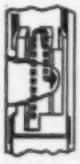
THE SHAFFER OIL-SEALED JAR SAFETY JOINT

The Shaffer Oil-Sealed Jar Safety Joint is the only tool that combines a choice of *jar-up* and *releasing* actions, both under complete control of the operator at all times. What's more, all operating parts are sealed in a chamber filled with clean oil, fully protected against mud, sand and corrosive fluids.

The sealed-in-oil protection not only safeguards against abrasion and corrosion, and minimizes pressure differentials on packing elements, but also insures constant operating characteristics at all depths. This makes the tool ideal for fishing, testing and similar strings where light connections and equipment are used!

Jar-Up Action

▶ **JARRING ACTION IS AUTOMATIC**—simply raise the drill string until tension equals the pre-set tripping load, whereupon a sharp up blow is struck. Lowering the tool automatically re-sets the tripping mechanism for another blow—and repeated blows can be struck as fast as the string can be raised and lowered.



Releasing Action

▶ **ONLY STRAIGHT PULL** is necessary to operate the tool—no torque or other secondary operations to affect the light connections commonly used in fishing, testing and coring strings.

▶ **TO RELEASE,** in the event the fish or stuck string cannot be loosened, simply trip the tool and apply reverse torque as the string is slowly lowered. Only one-sixth turn of the drive keys rotates them into an unlocking slot whereupon raising the string allows the parts to unlock.

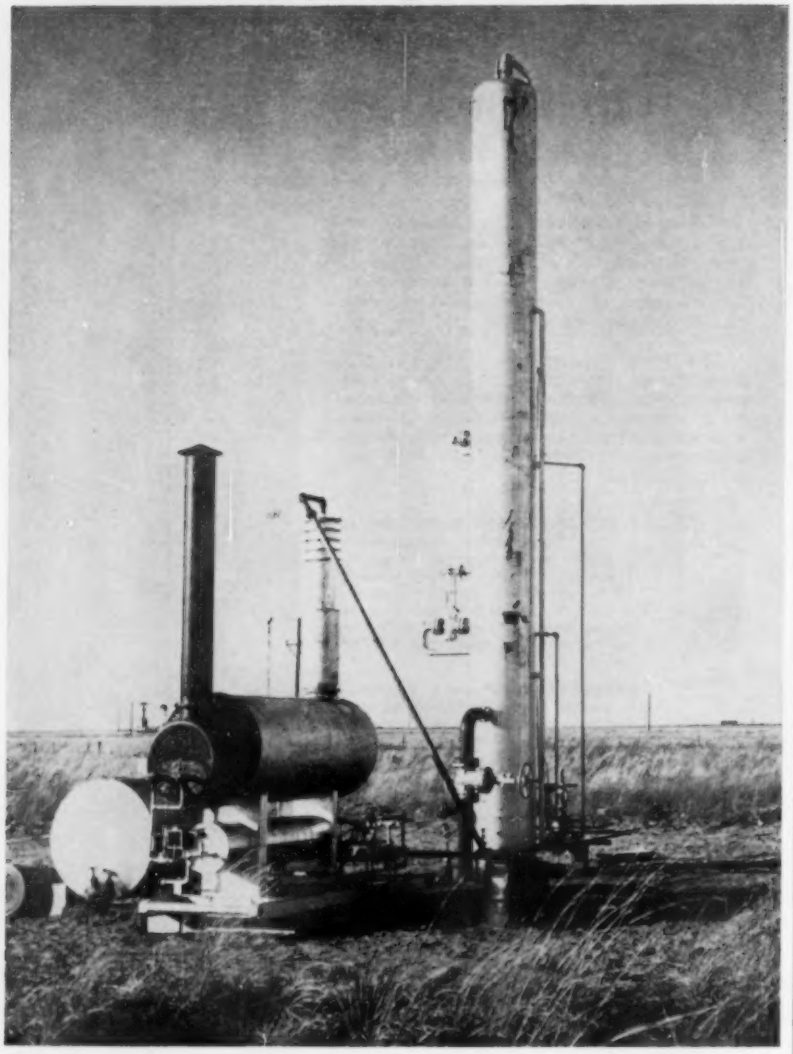
AND NOTE THIS—not only does the tool transmit full torque loads in *either* direction, but no threads are used in the releasing mechanism. Therefore there's no risk of torque over-tightening the tool—nor can reverse rotation accidentally release it.

Also, force of the blow is absorbed by integral knocker heads—not by easily damaged drive keys or threads. The tool is designed for *sustained* jarring operations. And since it does not depend upon friction for its tripping action, the Jar Safety Joint always operates with the same pre-set action. Light strings are not subjected to unpredictable loads!

Free 8 page booklet gives many other facts about the Shaffer Oil-Sealed Jar Safety Joint. Write for it—or ask your nearest Shaffer representative.

See the Shaffer section of your Composite Catalog.

New Process Solves Gas and Condensate Co-mingling Problems



Maloney-Crawford's new Duo-Dry process eliminates the need for separate lines to carry your gas and condensate from the well to central facilities. It can accomplish this even when line heaters have not been satisfactory. In the Duo-Dry process, a single contactor vessel dehydrates gas, then uses this under-saturated gas to strip solution water from condensate. The gas then is dehydrated in the usual manner. The dehydrated gas and condensate can be recombined in the same pipeline without the danger of downstream freezing. It is a trouble free process using only proven contact methods. No untried desiccants. The savings can be large for isolated wells, especially those in colder climates, and for offshore locations. Don't lay an expensive second line without investigating this low-cost alternative. Get the details today.

Maloney-Crawford

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machinery to today's highly technical requirements.

3. Intensify our efforts to sell our customers on the idea that unsound practices which tend to bankrupt the contractor will result in a loss to us both.

4. Pay more attention to our accountant, our banker and our personal company records and use these figures in arriving at the estimated cost of work performed and the price for these services.

5. Work cooperatively with other AOSC members in our area toward improved quality of our labor supply, not only for the present but for the future, realizing that new equipment is hard to come by and that only through properly trained personnel operating this equipment at a profit can we justify its purchase.

6. Help our customer accept the fact that we are an essential part of his business and know how to efficiently and economically take care of his service problems and therefore have a right to expect recognition as a member of his team.

7. Continue to work toward the adoption of a form of contract which can achieve general acceptance in the servicing industry, readily understood by both parties which plans the responsibility for neglect, risk and corresponding burden upon the party who should properly assume this burden. We should, however, consider the conditions under which the work was performed.

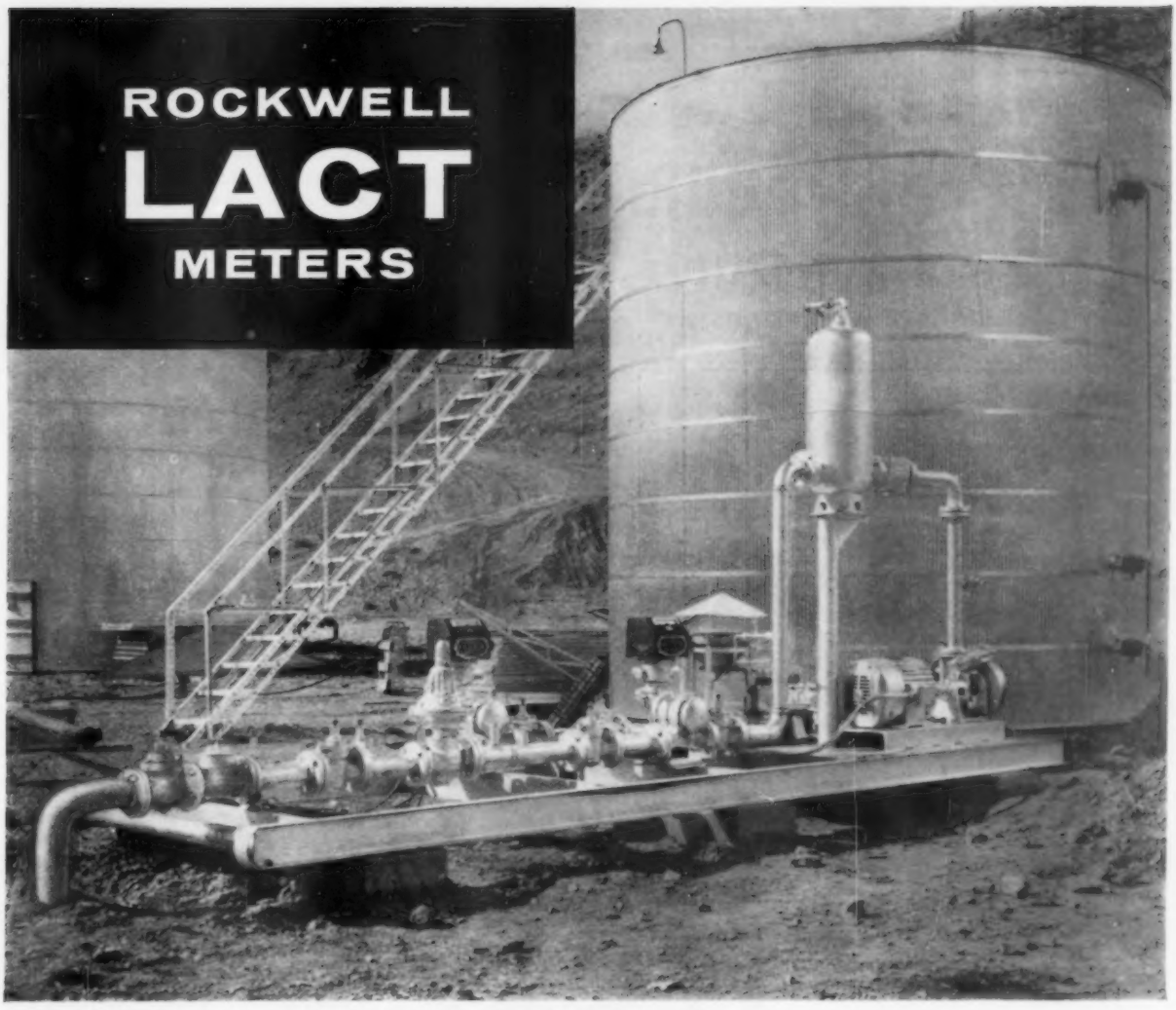
8. Emphasize personnel training among our supervisors and operators along the lines of economy, efficiency and customer problems by whatever methods we can devise to most appropriately accomplish the objective.

9. Accept the unpleasant idea that suppliers and manufacturers have to show a profit and cannot pay us an unreasonable price on "trade in" toward the purchase of new rigs and units, then junk or salvage them out and continue to stay in business himself. We and our customers have demanded improvements on brakes, clutches, sand lines, automation and auxiliary attachments and we and the customer will simply have to pay for these demands.

10. Continue to concentrate on safety and safety problems, realizing that a reduced premium will result in lower rig or compensation rates which may give each of us a competitive advantage.

11. Ask suppliers and manufacturers

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Cut transfer costs—
keep records straight

Metered ACT and LACT systems are in your best interests. They provide printed records for proof of conservation control. They lower your operating costs. They verify all quantities transferred. And metered systems provide reliable records for billing purposes as well as firm facts upon which to base royalty and tax obligations.

Rockwell meter systems combine *all* the components you need for protection and savings on your lease. Rockwell meters have an all-revolving measuring mechanism which turns freely on anti-friction bearings without metal-to-metal contact. Rockwell air eliminators insure accurate measurement of liquid volume by removing all entrapped vapors. Automatic temperature compensators translate metered measurement to a uniform base temperature. Ticket printing registers simplify your accounting. Electric impulse contactors actuate remote counters and/or control solenoid valves or pumps for automatic shut-off.

Rockwell meter systems have a proven record of success in oil fields throughout the world. For full facts write: Rockwell Manufacturing Company, Dept. 123C, Pittsburgh 8, Pa. In Canada: Rockwell Manufacturing Company of Canada, Ltd., Box 420, Guelph, Ontario.

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Do Double Duty
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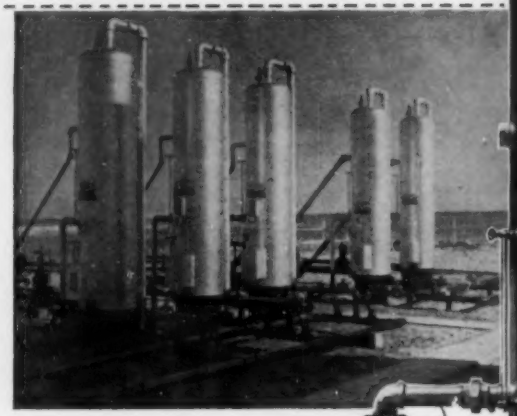
2 METER THEM



Battery of Model 24MS-0109C Type C Metering Separators

Model 24MS—0109C Type C Metering Separator

METROL® Metering Separators save you money. Simple and rugged design assures continuous trouble free operation. They are easy to maintain at peak performance because of well designed, well made controls.

METROL Metering Separators will separate the oil and gas and will meter the oil. Patented* Snap Acting Liquid Level Control and positive valving sequence assures metering accuracy as high as 99.99%.

Use of METROL Metering Separators is accepted by most regulatory bodies. They are ideally suited for metering oil for royalty and tax payments, for testing wells, producing mutiple completed wells into common storage tanks, test separators at tank batteries and Automatic Lease Operation.

Sizes available are 16, 20, 24, 30, 36, 48, 60, and 72 inch diameter with 6′ to 20′ shell lengths in 125, 300, 600, 1200, 1500, 1800, 2000, 2400, and 3000 psi W.P. The units will handle from zero to 20,000 BPD. Dump volumes range from ¼ bbl. to 30 bbls.

*U. S. Patent No. 2,818,738

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Every Unit is completely assembled, pressure tested, calibrated, and performance tested prior to shipment.

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to hesitate in starting new, untrained personnel in business which in some instances hurts us, the supplier, the producer and the entire well servicing industry.

12. Realize that as businessmen in our own community we have a personal responsibility toward areas of improvement in civic activity, schools, churches, and good oil field public relations. To be accepted as a good businessman in our own town we must devote our time, energy, effort, and money to help improve the society in which we live.

I cannot say which is the most important of the above items. They all go hand in hand like the links in your high speed chain. But I can say, unfortunately, no one can or will fight the battle for you and your only measure of business success is measured by a little six letter word, "profit."

Progress

I have talked to hundreds of customers, competitors, suppliers, and manufacturers and almost without exception they are troubled by current business conditions, suspicious of either the Democrats or Republicans, mad at price cutters, exasperated at the demands of the customer, oppressed by the creditors and in some instances busy as beavers. The ones busy as beavers were not those who spent a significant portion of their time at the coffee shops or with folded hands at their office waiting for the phone to ring. The busy ones were those out circulating, selling, and supervising and taking whatever action necessary to see to it that their business continued to progress.

In today's oil well servicing business there is no lead pipe cinch. While some periods are tougher than others and while other companies are waiting on that phone call, you and I should be studying the weakness of our competitors, improving on operating efficiency, weighing the merits of our key personnel and continuing to push for a larger share of tomorrow's business.

Tomorrow's business may come from problems you or I can or must tackle alone, others you may meet more effectively in cooperating with your competitors or others to whom the problems are common. Through group action offered by our association, we can and must attack problems, show a profit and make progress which we would find disastrous to try alone. Your participation in this association as a group will add much to the type of society in which we live. Unless we all work together, the old adage of hanging together may be applicable.

This is particularly true in today's servicing business.

We do live in a competitive society today and I am proud we do. But, unless those who have a competitive interest are willing to meet others with a competitive interest, then one or the other is going to perish. As long as each group is properly and equitably represented and as long as our society is able to express itself through groups such as this association, we will continue to have a true expression of democracy in action. But, through association, cooperation, unity, and standing together on problems that effect all of us we can continue to progress, and those that stand for nothing will usually fall for anything. ★ ★ ★

Automatic Remote Control Provided Offshore Wells

After more than ten months of stiff operational tests, an automatic remote control system for offshore petroleum production has been declared a success by Gulf Oil Corporation engineers.

One of the first of its type, system permits complete control from shore through an underwater electrical cable of three gas-condensate wells in Block 889 field in the Gulf of Mexico.

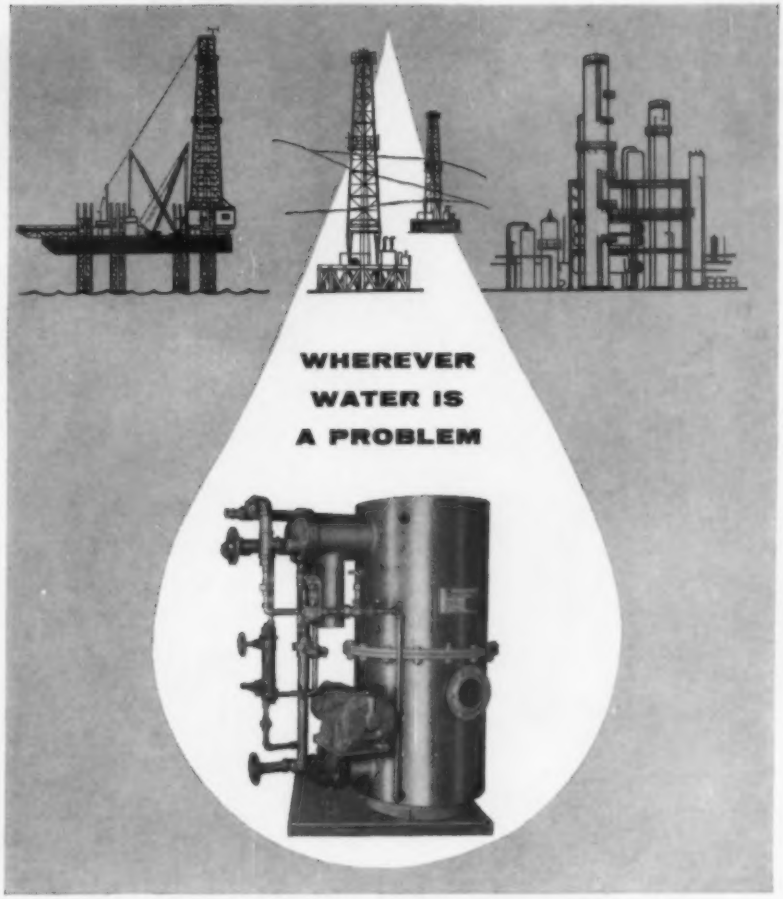
Located on a single platform, these three wellheads are controlled by an operator from a shore station 3½ miles away on Mustang Island.

New automation system permits remote supervision and control of four basic functions — placing wells in or out of production, regulation of flow rates by means of adjustable choke valves, control of temperature, and control of corrosion inhibitor facilities.

Installation permits measurement of such process variables as pressures, temperatures, and volumes at various points between wellhead and storage.

Each well and attendant facilities can be controlled independently from onshore console boards. To perform a function, operator dials a number, waits for a corresponding "point identification" number to appear on his receiver console, and then presses a "proceed" button. When valve is closed, a light on panel will confirm valve's new position.

Panel lights continuously indicate status of equipment, and entire system is designed to withstand extreme weather conditions.



AQUAVAP

HEAT RECOVERY EVAPORATORS
ARE THE FUEL-FREE, LOW COST ANSWER

Sold as a complete packaged unit, low in initial cost, inexpensive to maintain, and simple to operate, AMF-Maxim Aquavap evaporators are ideal for use offshore or on land. They convert salt or brackish water to fresh water, using engine jacket water or any other available hot water as a heat source. Thus their operation is fuel free. Five models are available with capacities ranging from 150 gallons per day up to 12,500 gallons per day. The purity of water produced exceeds U. S. Dept. of Health requirements.

Aquavaps are extremely compact. A unit providing, for example, up to 1,000 GPD is less than 4 feet high and laterally takes only about 2 x 4 feet of floor or deck space. Such a unit would weigh approximately 700 lbs. Other types of AMF-Maxim evaporators are available with capacities ranging from 150 to more than 1,000,000 gallons per day. For further information on the Aquavap, write to our Waterford address below.

AMF MAXIM EVAPORATOR DIVISION
American Machine & Foundry Company
WATERFORD, CONN. • Branch, DENVER, COLO.

Represented by THE J. B. BEAIRD COMPANY
Shreveport, New Orleans, Tulsa, Midland, Houston, New York

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Martin-Decker Electric Drilloger Recording Systems

For the recording of Total Hook Load, Pump Pressure, Pump Speed, Rotary Speed, Torque, Rate of Penetration, and R. P. M. Signals, and Pressure Signals to 20,000 pounds . . . Write for Bulletin E-P90.

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MARTIN-DECKER CORPORATION
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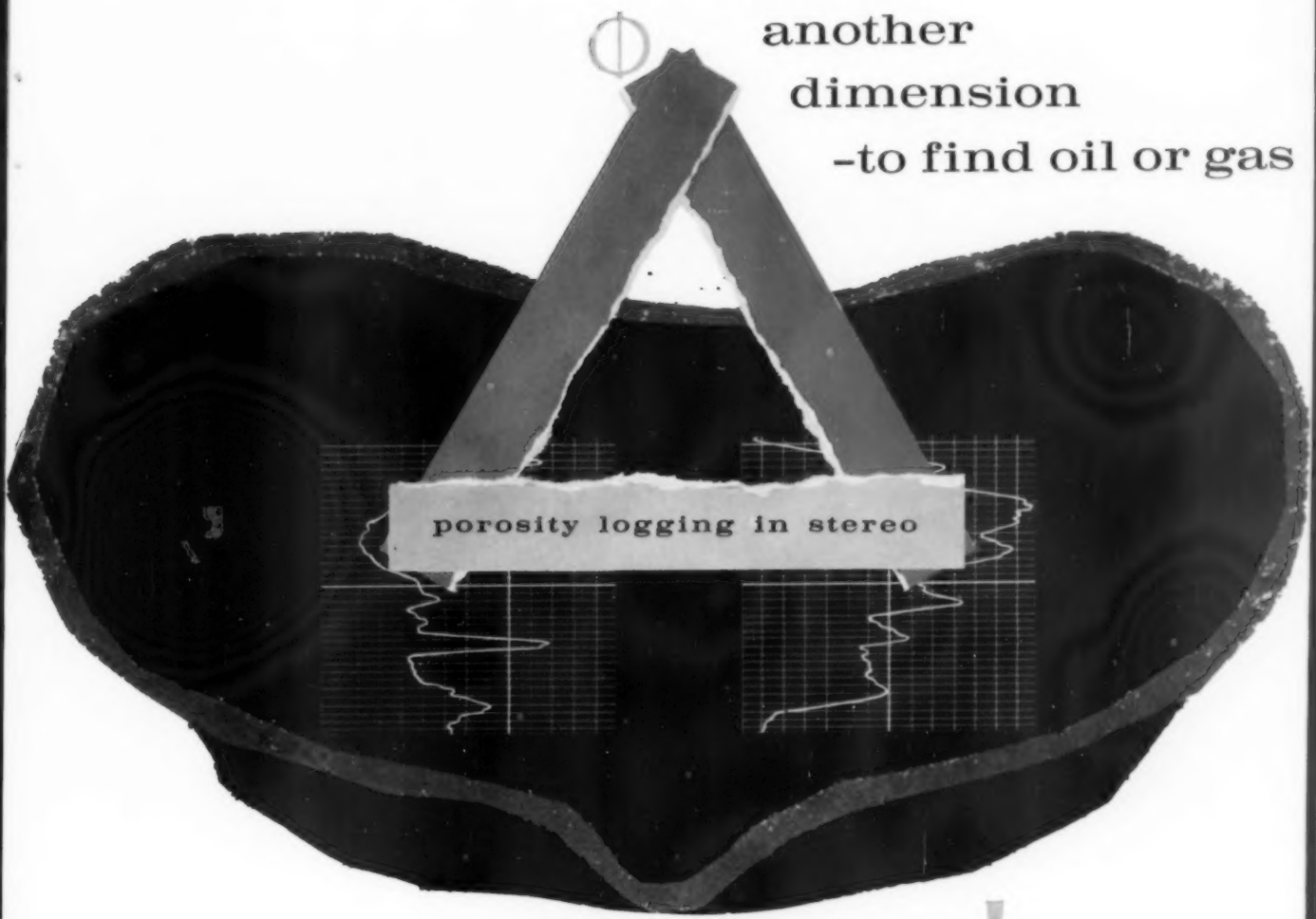
The World's principal manufacturer of Oil Well Drilling Instrumentation

look at another dimension -to find oil or gas



When two porosity devices disagree on the apparent value of porosity, *the difference is significant.*

Each log responds to a characteristic that is related to porosity; each log also may be affected by other characteristics in a particular manner.

For example, gas affects the Sonic and Neutron Logs in an opposite manner—the difference readily indicates the presence of gas.

The appropriate choice of porosity logs will depend upon formation and hole conditions. The following porosity tools are available from Schlumberger:

Sonic Log Microlaterolog Proximity Log
Neutron Log Gamma-Gamma Log Microlog

Consult your local Schlumberger engineer to determine the set of porosity logs which will give you an added "oil-finding" dimension.

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Security,
the bit with the
extra bite!

Pave the way to pay dirt fast with Security bits! Today, Security offers over 1150 sizes and types, designed to fit every drilling need. Security FIRSTS are built into every bit. Exclusive gas heat treating techniques assure maximum quality metal control. All-new, electronic equipment controls and checks bearings to microscopic-fraction accuracy. New Extended Jet bits give closer-to-bottom cleaning action with added penetrating speed. Exclusive nail-locks for jet bit nozzles make old-fashioned snap rings obsolete!

Write today to see why these Security Firsts give *EXTRA built-in bite* in every Security Bit!

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ONE OF THE DRESSER INDUSTRIES

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SUPPLIERS' PARADE

New Companies, Subsidiaries and Agents

Atlas Bradford Company has been appointed distributor of oil country tubular goods, manufactured by **Colorado Fuel & Iron Corporation,** Colorado. Distribution will be through Atlas Pipe Inc. and Bradford Supply Company, divisions of Atlas Bradford Company.

Atlas Powder Company and **The Stuart Company** announced signing of a memorandum of intent to merge. Stuart manufactures ethical drugs, Atlas, industrial chemicals and explosives.

Continental-Emsco Company has concluded arrangements with the **Oil and Gas Supply Company** of Houston to distribute their packaged Joy gas compressor units in the oil and gas fields of the U.S.

C. D. Fletcher, formerly of Merla Tool Corporation, has organized a company, **"Fletco Services,"** to specialize in design, installation and operation of closed, rotative gas lift systems.

Halliburton Company and **Welex, Inc.** announced a merger making Welex an operating division of Halliburton, rather than the independent subsidiary it has operated as since original purchase by Halliburton in 1957.

Oil Center Tool Company has named the **Wayte Industrial Supply Corporation** of North Dakota, as sales and service agent, in a move to provide more complete sales and service facilities for the Northern Rocky Mountain region.

Worthington Corporation appointed **Acme Foundry and Machine Company** of Kansas, as distributor of their oil field products, in addition to the Worthington power transmission products which they already handle.

OPW Corporation announced the opening of a new plant in Canada. **OPW-Jordan Ltd.** is located in Toronto, Ontario and will carry most OPW products within the near future.

Wintroath Pumps and Vertical Turbine Pump Divisions of **Worthington Corporation** have been consolidated into the Vertical Pump Division. The new division will have two plant locations, Denver and Alhambra, California.

Worthington has also named Bitco, Inc., of Spokane, distributor of their mechanical power transmission products.

Appointments and Promotions

Baash-Ross Division of Joy Manufacturing Company — **Ross Himmelreich,** manager of rental & service location in Edmonton, Alberta.

Borg-Warner Corporation — **Robert W. Halberg,** associate director-automotive department.

Chicago Pneumatic Tool Company — **Leonard H. Busby,** general manager, Oil Tool Division, Fort Worth; **Vernon Ash,** Gulf Coast division manager; **Robert Rendall,** district manager, West Texas; **Thomas Tefertiller,** assistant district manager, Oklahoma City.

Chiksan Company — Lee Guill, vice president-sales manager; **Gus M. Bagnard,** vice president-chief engineer; **E. Nelmes Thomas,** vice president-Chiksan International and manager of sales development.

Continental-Emsco Company — **Tom H. Fraser,** sales promotion manager; **William H. Clark,** district sales manager, Fibercast Company, Oklahoma; **John D.**

SCOTT-HYCALOG POWER SWIVEL

SAVED

75% USUAL COSTS!
80% USUAL TIME!
5 DAYS RIG TIME!
30% USUAL TIME!
65% USUAL TIME!

HYCALOG

Taken from actual records of drilling, coring and workover, these are but a few cases off the stack. The SCOTT-HYCALOG swivel eliminates the expense of rotary, Kelly and conventional swivel. Quick to rig up . . . Quick to move . . . it can be operated in any derrick or mast of any type which will support weight of the drilling string or tubing. *Let this swivel save money for you!*

HYCALOG, INC.

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OFFICES IN PRINCIPAL OIL PRODUCING AREAS

DIAMOND BITS • CORE BARRELS • WELL LOGGING • DIAMOND CORING • CORE ANALYSIS • POWER SWIVELS

Craddock, manager of Longview, Texas, branch store; **Robert M. Erskine,** assistant general sales manager-non-tubular goods.

Crucible Steel Company of America — **D. W. Kaufmann,** product manager-stainless steel; **J. W. Slattery,** manager-distribution relations.

Fairbanks, Morse & Company — **Thomas J. Bullock,** director of marketing, compressor division.

Gardner-Denver Company — **J. M. (Pepe) Estrop,** exclusive representative, Mexico.

Grove Valve and Regulator Company — **Len E. Brock,** regulator sales-service engineer for Permian Basin, formerly with Burt Tank Separator & Oil Treating Corporation; **Robert Churnside,** sales engineer-Chicago, formerly with F. H. Maloney Company in Houston.

Guiberson Corporation division of Dresser Industries, Inc. — **Robert L. Boyd,** executive vice president and general manager.

Hagan Chemicals & Controls, Inc. — **Davis D. Hunt,** manager, oilfield chemicals research and development group.

Hill-Hubbell Company — **Robert G. Meihls,** district sales manager, middle Atlantic States.

Hughes Tool Company — **Frank D. Potter,** assistant to the advertising manager; **W. H. Siems,** board of directors; **Raymond M. Holliday,** secretary.

Jones & Laughlin Supply Division — **C. R. Jones,** salesman, Amarillo; **J. H. Thompson,** salesman, Beaumont.

Kerotest Manufacturing Company — **E. N. Wrenshall,** vice president.

Lone Star Steel Company — **E. B. Germany,** president elected to board of directors; **James W. Aston,** president of Republic National Bank elected to board of directors.

Merla Tool Corporation — **C. D. Fletcher,** resigned to organize Fletco Services.

Mission Manufacturing Company — **George T. Mays,** sales representative, oilfield products, New Orleans.

Morse Chain Company — **Howard W. Bennett,** market manager.

Magnet Cove Barium Corporation — **George H. Moore,** vice president-marketing; **Doyle Waller,** coordinator, field training-sales and engineering, drilling mud department.

National Supply Division of Armco Steel Corporation — **John A. Emery,** assistant sales manager, **Charles A. McCollum,** Middle & Far East service manager retired after 40 years of service. **Donald G. Knox,** developer of gas lift equipment, retired after 24 years service in Torrance.

W. C. Norris Division, Dover Corporation — **Clint Cross,** vice president-manufacturing, succeeding **R. A. Colgin,** who retired.

Otis Engineering Corporation — **Wallace Robertson,** gas lift manager; **Carl O. Fleming,** manager of manufacturing; **Turner G. Garwood,** manager-Eastern Hemisphere, headquarters in London; **Harold Watson,** division manager, Servicio Technico de Pozos "Otis" C. A., headquarters in Las Morochas; **C. W. McComas,** packer sales coordinator.

Raybestos-Manhattan, Inc. — **R. B. Park,** sales manager-industrial rubber and mechanical packings.

Security Engineering — **John R. Schween,** Eastern division manager, Pennsylvania.

Tex-Tube, Inc. — **W. J. Goldston,** appointed to board of directors.

The **Jones Laughlin Supply Division** has moved its 1959 Oil Show display building to Borger, Texas, and set it up as a modern supply store.

James B. Hughes, vice president of the Hydril Company, will serve as president of the Houston chapter of the **National Oil Equipment Manufacturers and Delegates Society** for the new year.

Tube Distributors, California Inc. — **Edwin A. Raymond,** executive vice president.

Tuboscope Company — **Peter T. Blinco,** special sales representative, Midland.

Union Wire Rope, division of Armco Steel Corporation — **Charles J. Nurse,** branch manager, Houston; **G. E. Giese,** district manager, Oklahoma City; **E. C. Meggers,** Gulf Coast and Southwestern Regional Manager.

Penrod Drilling Company — **William Krisher,** contract representative, formerly with the Dallas Texans.

Electrodynamic Instrument Corporation — **Robert L. McCelvey,** manager of military department, formerly with Texas Research Associates.

Robertshaw-Fulton — **Alton W. Beck,** vice president, western operations; **Arthur G. Baitz,** director of marketing.

Tyson Smith Company — **Thomas J. Faver,** sales manager, oil and gas division.

Worthington Corporation — **Robert E. Marshall,** elected treasurer succeeding **W. R. Shook,** who resigned to become treasurer of Avon Products, Inc.; **C. Robert Maranville,** assistant treasurer; **Walther H. Feldmann,** chief executive officer, succeeding **Hobart C. Ramsey.**

Young Radiator Company — **Burton M. Joseph,** sales manager of the industrial and oil field division.

Alco Products, Inc. — **William A. Callison** elected to the board of directors.

Arcair Company—**Donald E. Shryock,** mid-western field representative.

Auto Crane Company — **Carl J. Hockenauer,** Southwestern sales manager.

Beaver Pipe Tools, Inc. — **William W. Mastern,** regional sales manager, Ohio.

Carlon Products Corporation — **John I. Rudge,** president; **William W. Clark,** secretary, formerly with Continental Oil Company.

Electrodynamic Instrument Corporation, a subsidiary of Reed Roller Bit Company — **Paul E. Madeley,** president, succeeding **Joseph J. Houghton.**

Franklin Pipe & Supply, Ltd. a subsidiary of Franklin Supply Company — **Robert H. Jackson,** storeman, Soldatna, Alaska.

M-B Engine Company — **John A. Boatman,** general manager.

Oildox Services, affiliate of Cardox, a division of Chemetron Corporation — **A. George Wright,** manager of Carbon Dioxide Engineering Services.

OPW Corporation—**George A. Halsey,** manager of customer service, Cincinnati.

Ralph M. Parsons Company — **Sturgis L. Stentz,** manager of petroleum automation department.

Pyle-National Company — **Richard J. Bayer** manager-lighting sales; **James M. Connell,** manager-Eastern region; **John M. Crocker,** manager-fitting sales.

Southern Pipe, division of U. S. Industries, Inc. — **F. W. Ryser,** sales representative-oil and gas pipe.

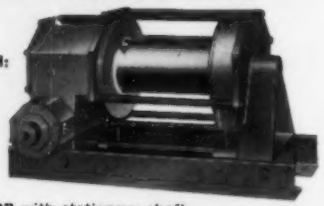
Koenig INTRODUCES A REVOLUTIONARY NEW TYPE OF HEAVY-DUTY POWER WINCH

FEATURING TORQUE TRANSMISSION DIRECT FROM GEAR SPIDER TO DRUM . . . NO KEYS TO SHEAR

20,000 pounds safe hoisting capacity

Outstanding features of the NEW KOENIG WINCH:

★ Drum torque load is NOT transmitted by drum shaft . . . no keys to shear . . . torque is transmitted direct from gear spider to drum by means of multiple-splined collar in gear housing.
★ Entire unit, including safety brake, is lubricated by the oil-bath principle, with a generous supply of oil to prevent overheating.
★ Engineered to use standard lubricants available throughout the world.
★ Multiple-plate automatic safety brake, running in oil with one-direction clutch, is easily adjusted or released.
★ Accurate drum clutch position indicator.
★ Gear ratio — 38:1.
★ Nickel-bronze alloy worm gear. Hardened and ground worm mounted on Timken roller bearings.



Model 70B with stationary shaft

Pat. Pend.

Model 71B with catheads

THIS ADVANCED-DESIGN KOENIG WINCH IS RECOMMENDED FOR OIL-FIELD EQUIPMENT, PUBLIC UTILITIES, HEAVY WRECKERS, CONSTRUCTION, AND OTHER HEAVY-DUTY JOBS.

Koenig winches have served the industry with dependable pull and hoisting power since 1934. Koenig also builds a complete line of utility and service bodies.

IRON WORKS, Inc.

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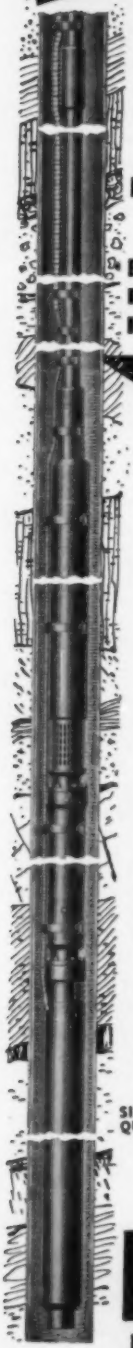
REDA PUMPS



FIRST CHOICE

FOR SECONDARY RECOVERY WATER FLOODING . . .

because pumping with REDA lowers costs and INCREASES PROFITS!

HERE'S HOW:

- Large water volume obtained from smaller size well casings reducing number of supply wells necessary
- Flexibility of Reda Pumps in meeting changing water requirements common to most waterflooding projects
- Easier, less expensive installation and lower maintenance costs
- Low operating costs and long operating life of Reda equipment
- Corrosion resistance of Reda pumps is superior to any other pumping unit used in supply wells

Reda Submergible Pumps are a major factor in the success of waterflooding and pressure maintenance operations. They are being used in major floods with very successful results of increased production and lowered costs.

Write for complete information today! Reda engineers will be pleased to call and assist in planning operations.

SIGN OF QUALITY . . SUBMERGIBLE REDA PUMPS

REDA PUMP COMPANY
BARTLESVILLE, OKLA.

General News

Baash-Ross Division of Joy Manufacturing Company has opened a new rental and service location in Wooster, Ohio, with A. J. Heath in charge of operations. The Indiana, Pennsylvania, office has been closed.

Johnston Testers, Inc.'s coring service is now available in the Rocky Mountains area. New locations are in Gillette, Wyoming, and Wolf Point, Montana.

Jones & Laughlin Supply Division has revised the territory of four sales districts. The former West Texas District has been combined with the Central Texas District, headquarters in Odessa. East Texas combines with North Louisiana, offices in Shreveport.

Four new members have been elected to the board of directors of the **Petroleum Equipment Suppliers Association.** They are: Paul F. Carmouche, J. T. Kenneally, and W. E. Scarborough from the Gulf Coast District; Elmer J. Weis, and Huntington Park from the Pacific District.

Raytheon Company opened a new sales and service office for electronic equipment in Houston.

Schlumberger Well Surveying Corporation's logging service is now available in Columbia, Mississippi. And in Beaumont, Schlumberger inaugurated its 25th year of service by opening a new and expanded service center.

Marsh Instrument Company, a division of Colorado Oil and Gas Corporation, has completed an extensive warehousing operation at Fort Lee, New Jersey. The set up will service the entire Eastern seaboard.

Pipe Line Service Corporation, a subsidiary of American Steel Foundries, has started construction of a steel pipe coating and wrapping plant in Youngstown, Ohio. They have also signed an agreement with Republic Steel Corporation which will expand Pipe Line Service's product line in 1961.

Kinzbach Engineering Company has been formed to continue the development, manufacture and marketing of the Kinzbach relief valves.

American Iron & Machine Works, Inc., specializing in oil field specialty items, has consolidated its Midland and Dallas-Fort Worth districts into one, with headquarters in Midland. Joe R. Thompson is the new division manager.

Oil Base, Inc., opened a new sales and service office in Corpus Christi for Black Magic oil base drilling fluid. A storage and distribution terminal has been established in Alice to serve the area.

Oil Recovery Corporation of New York and Tulsa has opened a district office in Midland, with Robert E. Chandler district engineer in charge.

SECONDARY RECOVERY

PETROLEUM ENGINEERS
STEPHENS ENGINEERING
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING
Water Flooding Gas Repressuring
EVALUATION CORE ANALYSIS
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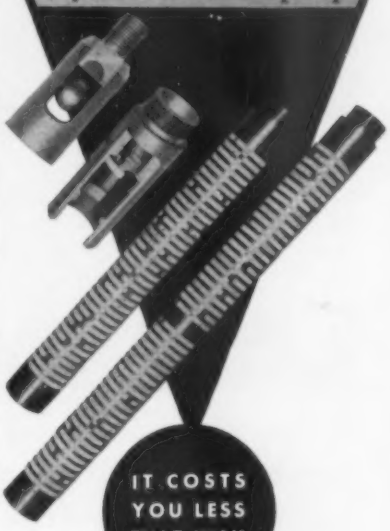
Let R-u-b-b-e-r Take The Wear

in your sucker rod pumps



IT COSTS YOU LESS THAT WAY

MARTIN RUBBER & DUCK RINGS give excellent life in dirty abrasive fluids . . . high or low gravity . . . much or little water . . . shallow or deep wells. They last for years in the easier pumping wells. Replacement rings cost comparatively little.

MARTIN PLUNGER BODIES, precision grooved, drilled and threaded (no underneath fluid passage), usually last for years. Tube or barrel costs are often cut in half.

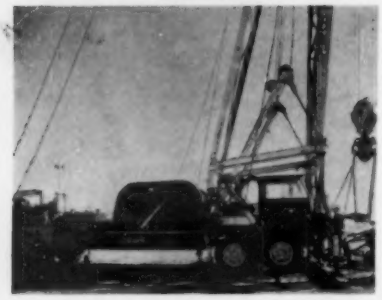
The replaceable SYNTHETIC RUBBER GUIDES in MARTIN CAGES last longer than any metal, and the cushioning of the ball increases your ball & seat life. Results are often truly amazing. (Patent No. 2,591,174)

Write for our new catalog or see it in the Composite (24th Edition). All products sold thru supply companies.

JOHN N. MARTIN
Manufacturer
9 W. BRADY STREET • TULSA, OKLAHOMA

What's doing in DRILLING

Self-Propelled Rig Used In Fast Shallow Drilling



— photo courtesy of National Supply Company

Drilling to 3500 to 3800 ft in four to five days has become routine, Carmack Drilling Company of Denver reports on their results in the Craig, Colorado, area with a self-propelled workover and service rig.

Carmack used the first model of a new, compact rig which is equipped with a propeller-shaft rotary drive for shallow drilling.

Drilling string generally run on these wells was a 3½-in. OD internal flush drill pipe with ten 4¾-in. OD drill collars. Carmack set 5½-in. OD casing strings into 6¾-in. holes.

Mounted on a 35 ft long chassis with tandem axles at both driving and steering ends, rig provides for erecting a 97-ft folding mast over front end of the unit. Average dismantling time is 45 min, Harold Carmack, president of the company, said. Rigging-up takes from 1½ to 1¾-hr.

An engine rated for 260 hp at 1800 rpm powers the unit through a three-speed transmission driven through a torque converter. Three independent power take-offs divert engine horsepower to drive the vehicle, drawworks and rotary, and power hydraulic system for power tongs and slips.

Folding mast is rated for 180,000 lb with six lines strung to traveling block and dead-ended to mast superstructure. Folding outriggers make ground guy lines unnecessary.

Drilling Practices School For Gulf Coast Scheduled

Inaugural spring session of new Gulf Coast School of Drilling Practices at Lafayette, Louisiana will be held in two half-sessions, from April 3 to April 14 and from May 1 to May 12.

"This school is unique in that it concentrates on drilling problems encountered in the coastal areas of Louisiana and Texas, where drilling is extremely hazardous and costly because of very high pressures," Carl A. Kinney, drilling superintendent for The Atlantic Refining Company at Lafayette and chairman of school's advisory committee, said. "It is designed for men who actually supervise drilling operations at the well site, who have to make immediate decisions in critical situations that can directly affect the success or failure of drilling operations."

Held for the first time last fall, nonprofit school is sponsored by the American Association of Oilwell Drilling Contractors in cooperation with Petroleum Engineering Department of University of Southwestern Louisiana at Lafayette, site of the school.

More than 40 specialists will instruct the drillers, toolpushers, and drilling foremen attending the school. Scholarships provided by companies sending men to the school are set at $200 per student for the entire session.

Coordinator for the school is Dr. G. G. Varvaro, Head of Southwestern's petroleum engineering department. Other members of school's advisory committee include W. C. Fatjo, owner, W. C. Fatjo Drilling Company; Harvey Fitzpatrick, drilling engineer, The California Company; W. A. Grapes, president and general manager, Gradome Drilling Company; Keith Lindley, district manager, Sunray Mid-Continent Oil Company; and Kirby Simmons, vice-president, Nicklos Drilling Company of Eunice.

AAODC Says Drilling Volume, Prices Decline Sharply

Drilling contractors experienced another sharp decline in drilling volume they performed during 1960, and they suffered a further deterioration in footage prices, Warren L. Baker, executive secretary of American Association of Drilling contractors, revealed recently.

Baker pointed out further that there was an even larger reduction in number of drilling rigs able to find work in U.S. Contractors were in effect drilling themselves out of business as hole penetration rates increased to a new peak.

These conditions resulted in an increasing number of mergers, foreclosures, and voluntary withdrawals from contracting, Baker said.

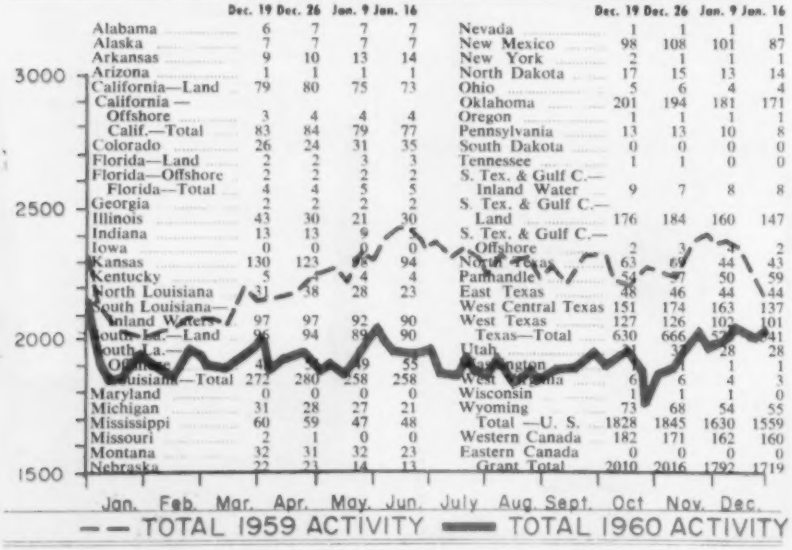
Only increase noted was in percentage of wells drilled by contractors, which rose to 95%, an increase of 1% from 1959.

Practically no change in cost of major drilling equipment was reported by Baker during 1960. Minor in-

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oil Well Drilling Contractors by Hughes Tool Company.

	Dec. 19	Dec. 26	Jan. 9	Jan. 16
Alabama	6	7	7	7
Alaska	7	7	7	7
Arkansas	9	10	13	14
Arizona	1	1	1	1
California—Land	79	80	75	73
California — Offshore	3	4	4	4
Calif.—Total	83	84	79	77
Colorado	26	24	31	35
Florida—Land	2	2	3	3
Florida—Offshore	2	2	2	2
Florida—Total	4	4	5	5
Georgia	2	2	2	2
Illinois	43	30	21	30
Indiana	13	13	9	8
Iowa	0	0	0	0
Kansas	130	123	96	94
Kentucky	5	4	4	4
North Louisiana	31	38	28	23
South Louisiana— Inland Water	97	97	92	90
South La.—Land	96	94	89	90
South La.— Offshore	4	7	9	55
Louisiana—Total	272	280	258	258
Maryland	0	0	0	0
Michigan	31	28	27	21
Mississippi	60	59	47	48
Missouri	2	1	0	0
Montana	32	31	32	23
Nebraska	22	23	14	13
Nevada	1	1	1	1
New Mexico	98	108	101	87
New York	2	1	1	1
North Dakota	17	15	13	14
Ohio	5	6	4	4
Oklahoma	201	194	181	171
Oregon	1	1	1	1
Pennsylvania	13	13	10	8
South Dakota	0	0	0	0
Tennessee	1	1	0	0
S. Tex. & Gulf C.— Inland Water	9	7	8	8
S. Tex. & Gulf C.— Land	176	184	160	147
S. Tex. & Gulf C.— Offshore	2	3	4	2
North Texas	63	69	44	43
Panhandle	54	57	50	59
East Texas	48	46	44	44
West Central Texas	151	174	163	137
West Texas	127	126	102	101
Texas—Total	630	666	523	541
Utah	31	32	28	28
Washington	1	1	1	1
West Virginia	6	6	4	3
Wisconsin	1	1	1	0
Wyoming	73	68	54	55
Total —U. S.	1828	1845	1630	1559
Western Canada	182	171	162	160
Eastern Canada	0	0	0	0
Grant Total	2010	2016	1792	1719



creases in price of combination hooks and rotary slips were noted, while price of drill collars declined by 6.8%.

A continued reduction in footage prices for rotary work during 1960 was indicated by an AAODC survey, despite a substantial increase in average depth of wells contracted for rotary drilling and despite contractors furnishing additional services.

Survey indicated that contract depth of rotary-drilled wells advanced to an average of 6124 ft per well during 1960. U.S. contractors received an average of $4.11 per ft, excluding daywork charges.

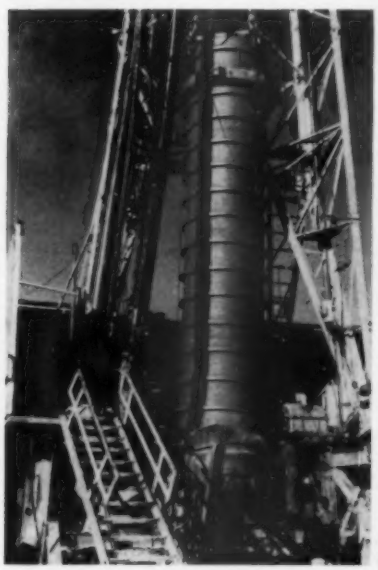
Here's how this compares with previous charges:

In 1959, contractors received an average of $.22 more per ft than in 1960, although depth of wells drilled averaged 248 ft less per hole.

In 1958, average depth of contractor rotary-drilled holes was 589 ft less than in 1960, but contractors were paid $.16 more per ft than during that year.

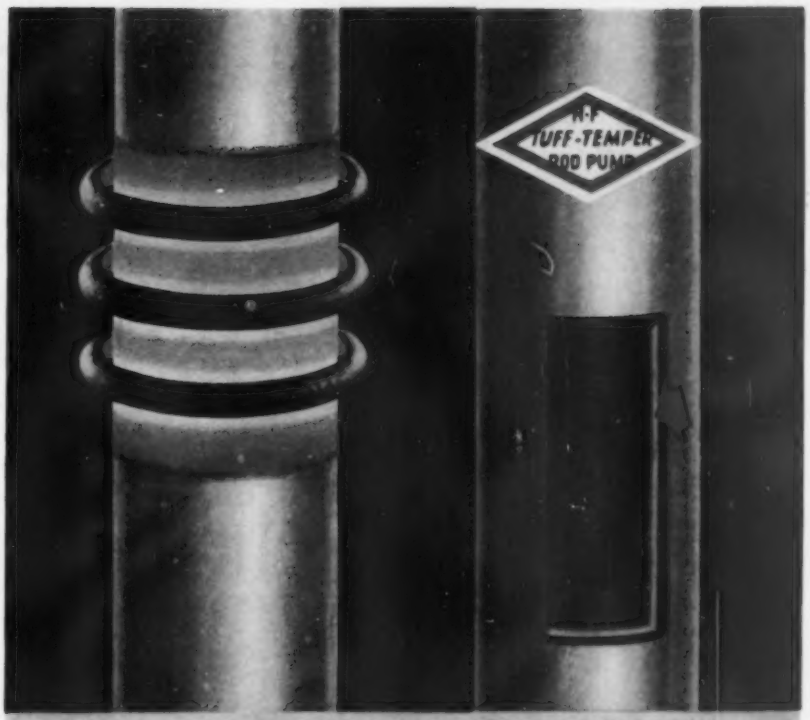
In 1957, rotary-drilled wells averaged 293 ft less in depth than in 1960, but contractors received $.40 per ft more than in 1960.

Kermac Sets 78½-in. Casing



— photo courtesy Kerr-McGee Oil Industries, Inc.

Setting 78½-in. OD casing into a 90-in. diameter rotary-drilled hole was completed to a depth of 710 ft by Kerr-McGee Oil Industries for a subsidiary, Kermac Nuclear Fuels Corporation in Ambrosia Lake area near Grants, New Mexico. One of largest rotary-drilled in United States, it will serve as air vent and escape hatch for company's uranium ore mine. Kerr-McGee's Rig 7, rated as a medium-depth 10,000 ft rig, performed job with a modified substructure to allow passage of 90-in. bit.



Through the Magic of Electronics...

Tuff-Temper® Barrel Tubes Run Longer in Pumping Abrasive Fluids

For the longest and most dependable service from a sub-surface pump running in abrasive fluids, your best choice is a barrel tube with a hardened wearing surface. From that point on, the rest is easy: Run a Tuff-Temper pump — the Best Pump in the Oil Patch to resist the abrasive effects of sand, scale, etc., that would cause undue wear and shorten the life of the pump.

Electronics puts the toughness and the temper in Tuff-Temper barrel tubes — where the wear-resisting properties are most needed. Each tube is heat treated by high-frequency induction hardening machines, the latest and surest method for exact control of temperature for uniform hardness and dense grain structure. The hard wearing surface produced by this method extends to a depth of 1/32", and the outer portion remains ductile and shock-resistant.

After the induction hardening process, the tubes are straightened on special machines, the inside working surface is expertly honed and polished to a mirror finish, and each barrel is checked against a full set of A.P.I. gauges. Heavy-duty pumps for deep-well production and chrome-plated plungers for extra hard wear can be furnished if desired.

Leading stores carry Tuff-Temper rod and tubing pumps in a wide range of A.P.I. types and sizes. You can obtain complete details and illustrated literature from your own store, one of our many factory warehouses or field representatives, or by writing to us at P. O. Box 2477 in Fort Worth. There is no obligation, of course.

H-F

"BEST PUMPS IN THE OIL PATCH"

HARBISON-FISCHER MFG. CO.

FORT WORTH

It's New

Drilling-Producing Equipment

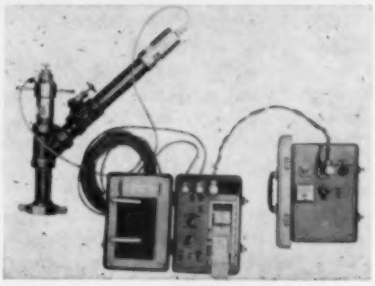
3-Way Small Valves

A three-way Micro Valve features male pipe connections which turn, permitting installation without unions. Valves operate at pressures up to 100 psi, and are available with a variety of orifice sizes, materials, and types of operating devices. Two or more valves may easily be manifolded together for multiple operation. *Instruments, Inc.*

Circle number (1) on reply card.

Well Fluid Level Finder

Completely portable Servco Fluid Level Finder requires only one man to operate and produces the average record in less than ten minutes. Level finder is designed to give accurate fluid level of an oil well and requires no special operators skills. Sound pulse is created at well head by firing a blank cartridge in annular space between casing and tubing, which travels down well and is reflected back by tubing



collar joints and surface of oil. Other obstructions such as liner, hangers, etc., are reflected and picked up by a microphone, amplified and recorded on a chart. Device obtains average record in less than ten minutes, including hook-up. *Servco Company.*

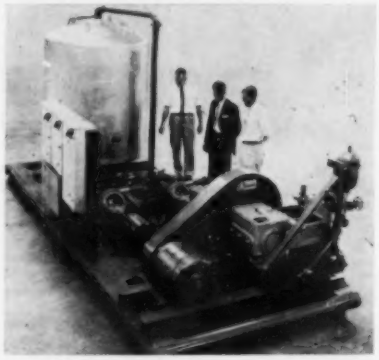
Circle number (2) on reply card.

Sonic-Caliper Log

Schlumberger has combined its sonic log with a caliper log in a single, simultaneously-recorded operation. Caliper log aids interpretation of sonic log and helps identify formations which are permeable, manufacturer says. Simultaneous recording of two logs on same film facilitates interpretation and reduces rig time used in logging. *Schlumberger Well Surveying Corporation.*

Circle number (3) on reply card.

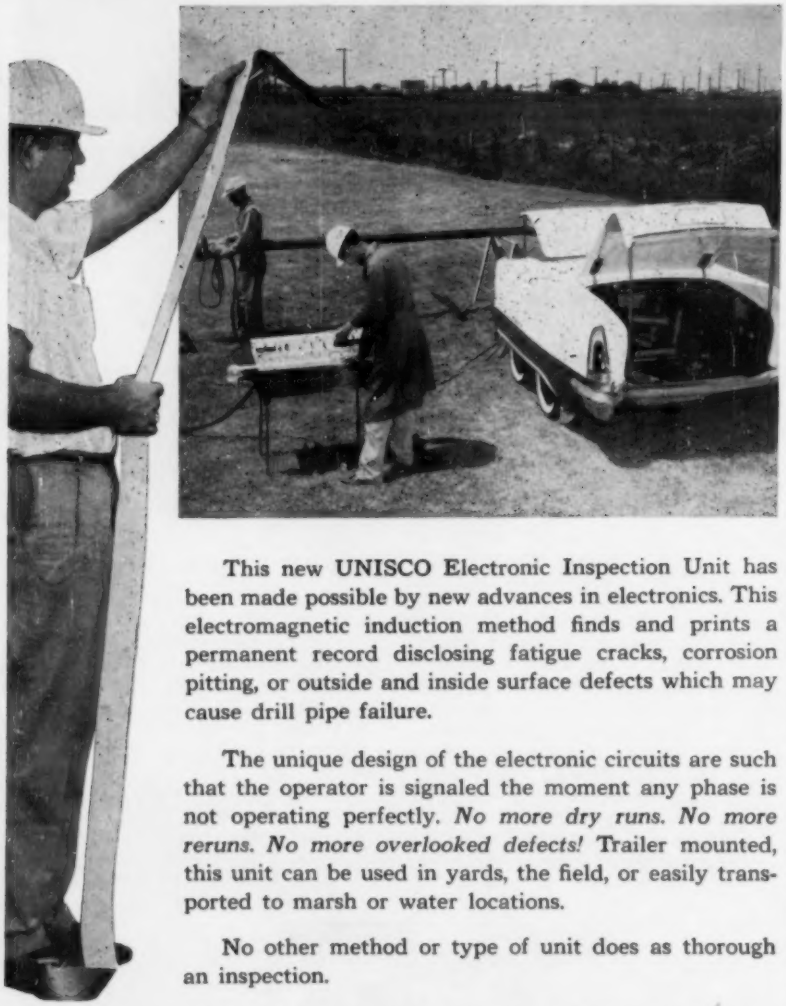
Electrically-Powered Portable Waterflood Unit



Jones and Laughlin Supply has designed and built their first portable waterflood unit. Compact unit designed for pilot flood operation includes an injection pump and driver, circulating and backwash pumps, water filter and control equipment. Components are mounted on a steel skid with walk-around space for access during operation and maintenance. Controls for automatic operation are centrally located and installation on a lease in Oklahoma required only necessary electrical and water connections. Unit has a Gardner-Denver Model PG-3, 3-in. stroke horizontal triplex plunger pump driven by a 40-hp electric motor. Capacity of unit is 300 bbl per day at maximum discharge pressure of 940 psi. *Jones and Laughlin Supply Division.*

Circle number (4) on reply card.

CALL "UNISCO" FOR THE BEST IN DRILL PIPE INSPECTION



This new UNISCO Electronic Inspection Unit has been made possible by new advances in electronics. This electromagnetic induction method finds and prints a permanent record disclosing fatigue cracks, corrosion pitting, or outside and inside surface defects which may cause drill pipe failure.

The unique design of the electronic circuits are such that the operator is signaled the moment any phase is not operating perfectly. *No more dry runs. No more reruns. No more overlooked defects!* Trailer mounted, this unit can be used in yards, the field, or easily transported to marsh or water locations.

No other method or type of unit does as thorough an inspection.

UNIVERSAL INSPECTION & SERVICE CO.

A Division of

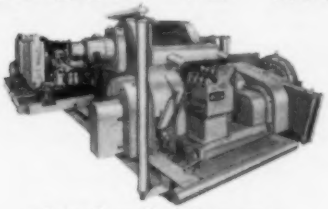
ATLAS BRADFORD COMPANY

Houston JA 6-1901, New Iberia EM 4-8666, Odessa EM 6-8241

Don't fight it...

CHECK

WILSON SUPER MOGUL "42" RIG



• Priced well below any comparable competitive rig

Wilson

WILSON MFG. CO., INC.

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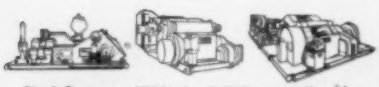
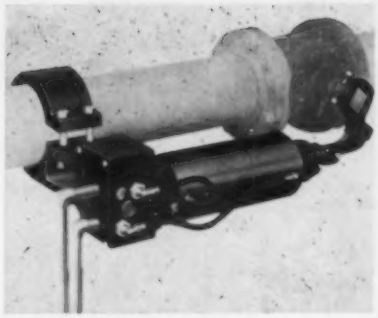
Winchmobiles Traveling Blocks Speedwinches



Slush Pumps 3000' to 25000' capacity Rigs



Valve Actuator

Valve actuator designed for operation on both plug and butterfly valves up to 12 in. in diam is available from Pantex. Complete assembly is supplied and it is not necessary to remove valve from service. Power can be provided by plant air, bottled dry gas, natural gas, hydraulic fluid or water. Actuator can also be operated by remote control through use of solenoid control valving mounted in bracket housing. *Pantex Valve Actuators.*

Circle number (5) on reply card.

Fresh Water Supply

A compact heat recovery evaporator, Aquavap, brings moderate-capacity fresh water production to users for whom larger custom-designed evaporators are impractical. AMF-Maxim evaporators convert salt or brackish water to fresh water at no fuel cost, as their heat source is usually engine jacket water. As evaporators operate under vacuum, raw water is boiled at very low temperature (about 125 F), minimizing scale formation. Units producing up to 500 gpd are less than four ft high and have a base less than two by three ft. Producing as much as five gpd per unit of hp, capacities range from 500 to 12,500 gpd. *American Machine and Foundry Company.*

Circle number (6) on reply card.

Well Foaming Agent

A foaming agent developed by Armour for fighting water encroachment in air drilling is a liquid cationic surfactant called Armomist. Producing large quantities of a stable, light density foam, it is not affected by high concentration of dissolved solids, manufacturer states. Agent has corrosion-inhibiting properties and serves as a shale-conditioning agent. Field tests indicate agent lowers surface tension and has a high salt content. It appears to be most effective in medium flow, from 5 to 50 bbl water intrusion an hour. *Armour Industrial Chemical Company.*

Circle number (7) on reply card.

High Pressure Valve

Companion model has been added to 900 Series Hi-pressure Shutoff Valves being produced by Circle Seal. Valve is rated to 6000 psi operating pressure in liquid or gaseous service. Constructed entirely of stainless steel with Teflon seals, it is specificially intended for use where corrosive conditions are exceptionally severe. Internal design features standard Teflon V packers which seat against a Belleville washer for seal, and it has a floating sleeve which rises to protect V packers from fluid flow when valve is open. Stem threads are completely removed from flow path, and double-tapered stem design provides a gradual throttling when valve is closed. *Circle Seal Products Company, Inc.*

Circle number (8) on reply card.

WHEN YOU ENCOUNTER EXCESSIVE TORQUE, DRAG OR THE HAZARD OF STICKING DRILL PIPE AND CASING....

SOUTHWESTERN

92

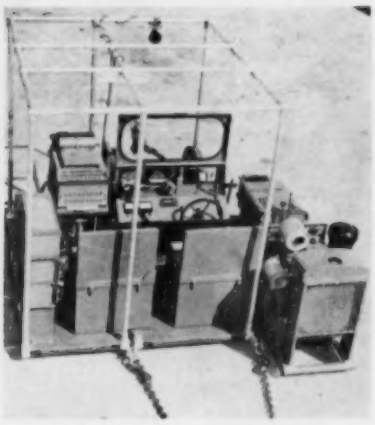
FLAKE GRAPHITE

excellent dry lubricant • inert • compatible with any mud • mud rheology unaffected • mixes readily • inexpensive • minimum graphitic carbon 92% • durable, weather-resistant 50-lb. bags

SOUTHWESTERN GRAPHITE COMPANY

GRAPHITE ROAD • BURNET, TEXAS

Air-Borne Logging Service



Schlumberger has developed a lightweight air-borne unit for supplying logging and completion services to remote and ordinarily inaccessible well locations. Unit divides into three principle sections, each weighing 2000 lb or less. These components, consisting of recording equipment, winch, and engine drive sections, can be assembled at well. A special new multiconductor logging cable of small diameter holds down gross weight, but allows running of all types of services to depths as great as 11,000 ft. Several of these units have been shipped to Canada, and they may also find use in offshore workovers. *Schlumberger Well Surveying Corporation.*

Circle number (9) on reply card.

Automatic Engine Controller

Fully-automatic engine controller is now being offered by Frank W. Murphy. From signals giving time, pressure, temperature, level, or other contact, these controllers are designed to automatically start any internal combustion engine and operate it on demand. If a-c current is not available to operate time switch, company offers an engine battery-powered seven-day program timer. *K. W. Murphy Manufacturer, Inc.*

Circle number (10) on reply card.

Waterflooding Valves

Expanded line of EValcoat plastic-coated steel valves designed especially for waterflooding and other secondary recovery and pressure maintenance systems has been introduced by Edward Valves. Plastic-coated globe valves, ball check valves, and strainers for waterflooding are now available from Edward in 1-in. size with screwed ends. A full line of non-coated companion valves and strainers from ½ to 2-in. size is available for applications that do not need plastic protection. Both plastic-coated and non-coated globe valves, and strainers are rated for working pressures to 2000 psi, with non-plastic coated globe and check valves available for pressures to 10,000 psi. *Rockwell Manufacturing Company.*

Circle number (11) on reply card.

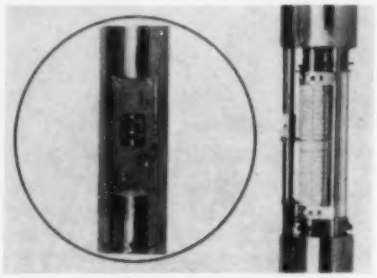
Medium-Range Compressors

White Diesel Engine is producing a line of medium speed, balanced-opposed compressors for gas gathering, lifting, repressuring, and booster service. Two cylinder, W-62, and four-cylinder, W-64, compressors have been designed for continuous, unattended, heavy-duty service and have been engineered for direct drive with White Superior natural gas engines. Matched engine-compressor units are available from 200 to 1000 bhp operating at 600 to 900 rpm with compressor using a 6-in. stroke. Two-cylinder covers a range from 200 to 635 hp. Supercharging brings four-cylinder compressor's engine to 1000 hp. There are 68 standard cylinder sizes available, ranging from 4000 psi with 2⅝-in. diam cylinder to 85 psi with 22½-in. diam cylinder. *Write Diesel Engine Division.*

Circle number (12) on reply card.

Self-Contained Logging Unit

Completely self-contained electric well-logging unit has been developed by Electro-Technical. Unit requires no additional equipment and can be used with standard-type probes. It is lowered into the hole on a wire line to record two separate traces and can be handled and operated by a



driller. Measuring just 2¾-in. in diam and 98-in. in length, electric logging tool is completely transistorized and carries its own batteries. *Electro-Technical Labs.*

Circle number (13) on reply card.

Weed-Killing Herbicide

An industrial herbicide with a wide range of weed-killing potency has been introduced by United States Borax and Chemical. UREABOR 31 formulation has been field-tested for four years on industrial sites in 26 states and Canada, manufacturer states. It is designed for killing marginal weed species such as dandelion, plainain, chicory, daisy, bouncing bet, dock, thistle, and woody vines and shrubs. Available in granular form, it is intended for killing fire-hazardous weeds in a single treatment and providing maintenance-free surface for a year or longer. *United States Borax and Chemical Corporation.*

Circle number (14) on reply card.

Turbine Chain Drives

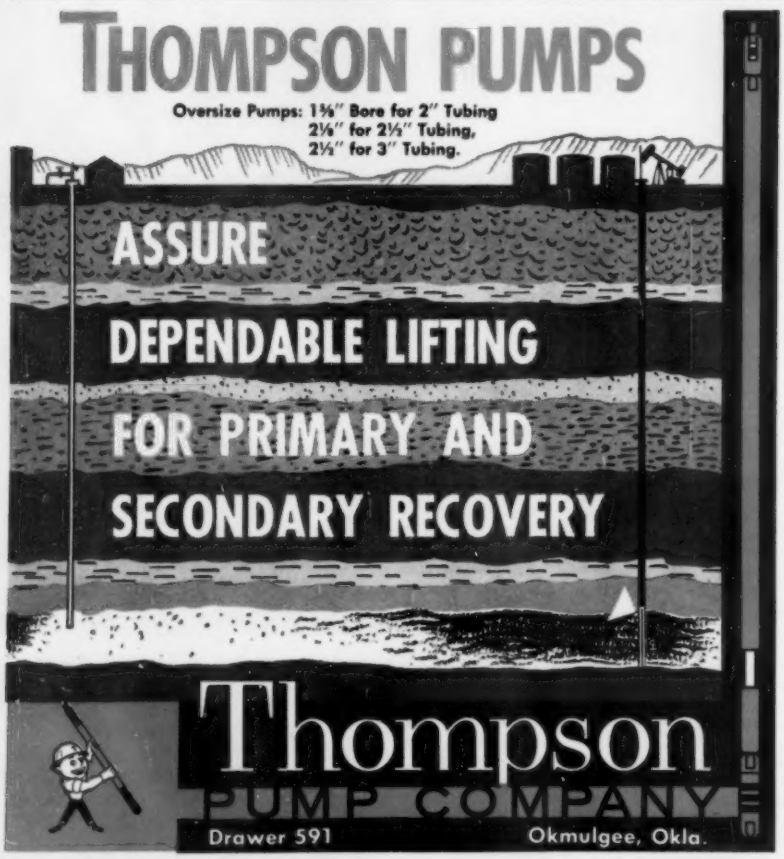
Morse has developed chain drives for transmitting power of small gas turbine engines from 30 to 1800 hp. These chains serve both main and auxiliary drives and can transmit rotating power between parallel shafts at high speed. Designated Hy-Vo (high velocity-involuate sprocket), new chain is a refinement of silent chain principle for extremely high speeds and heavy loads. It incorporates compensating links that fully eliminate chordal action normally encountered at very high chain speeds. *Morse Chain Company.*

Circle number (15) on reply card.

Diethylene Glycol

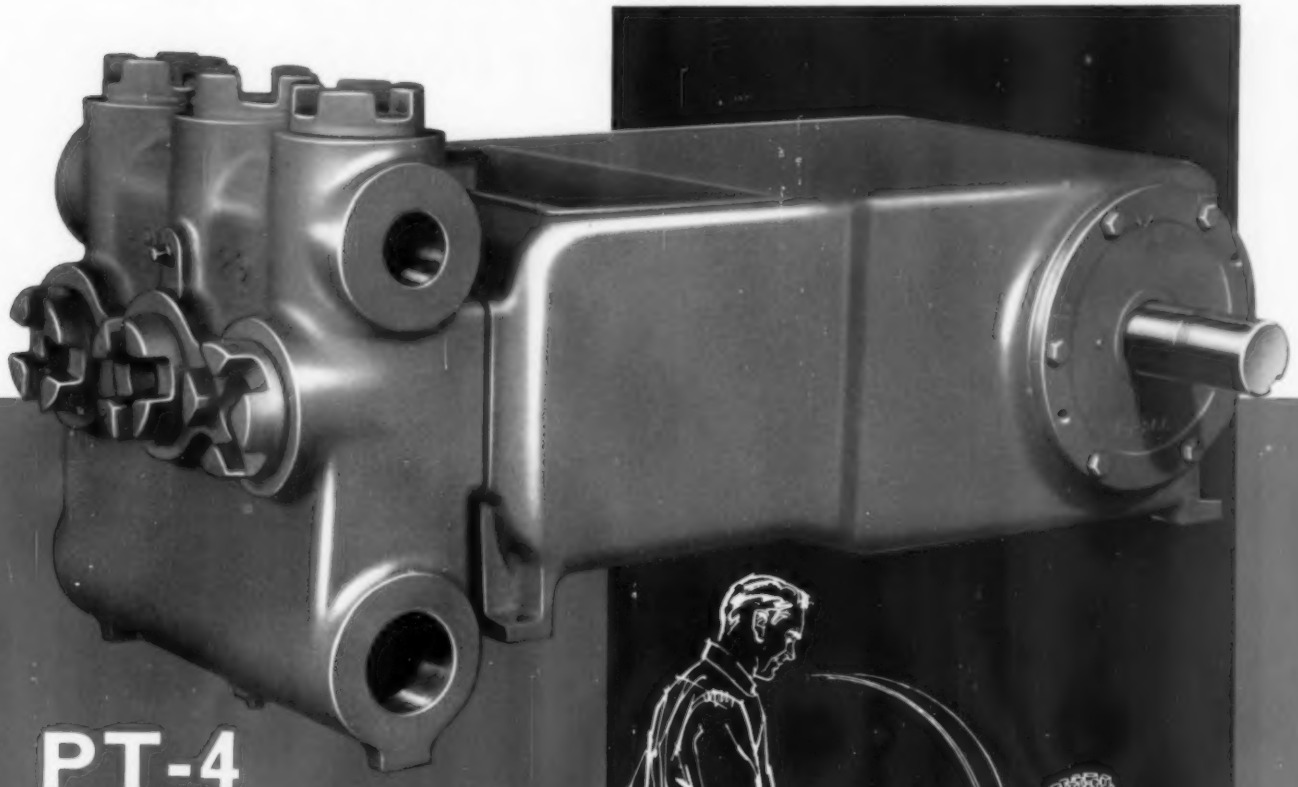
Union Carbide has improved their standard grade of diethylene glycol. New grade has narrower distillation range, more precise water-content control, and reduced acidity. *Union Carbide Chemicals Company.*

Circle number (16) on reply card.



With faith in the industry's future . . .

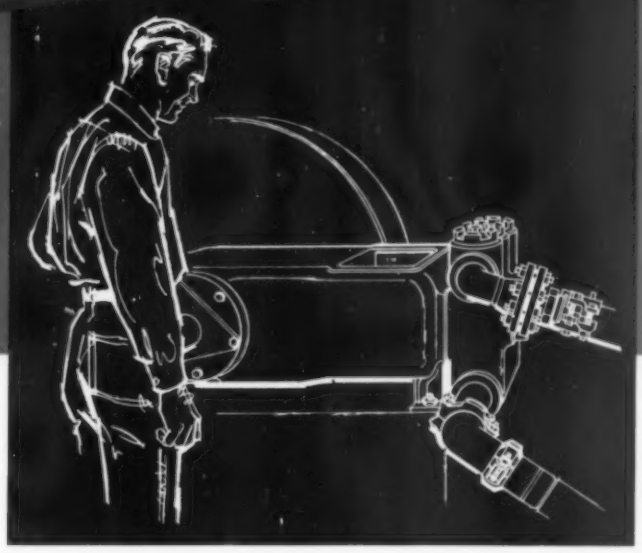
GARDNER-DENVER MAKES THE NEWS



PT-4

3½ x 4 triplex plunger pump

70 hp input at 400 rpm. Plunger load: 4910 lb.
Capacity from 199.9 gpm at 510 psi to 25.6 gpm at 3000 psi.



Another NEW

continuous service waterflood pump in the Gardner-Denver quality line

Now you can choose from a still wider range of Gardner-Denver pumps for secondary recovery and salt water disposal. Gardner-Denver's new PT-4 triplex plunger pump is ruggedly built to give you long, long, trouble-free service. It's engineered and constructed with the quality you expect in Gardner-Denver pumps. For continuous waterflood service, choose the Gardner-Denver pumps to meet your specifications. Write for bulletin 3-3Q.

CHECK THE QUALITY BUILT INTO THE PT-4:

- Gardner-Denver wing-guided aluminum bronze valves
- direct drive through crankshaft
- one-piece aluminum bronze fluid cylinder
- removable stuffing boxes
- insert-type connecting rod bearings
- full splash lubrication
- double extended crankshaft

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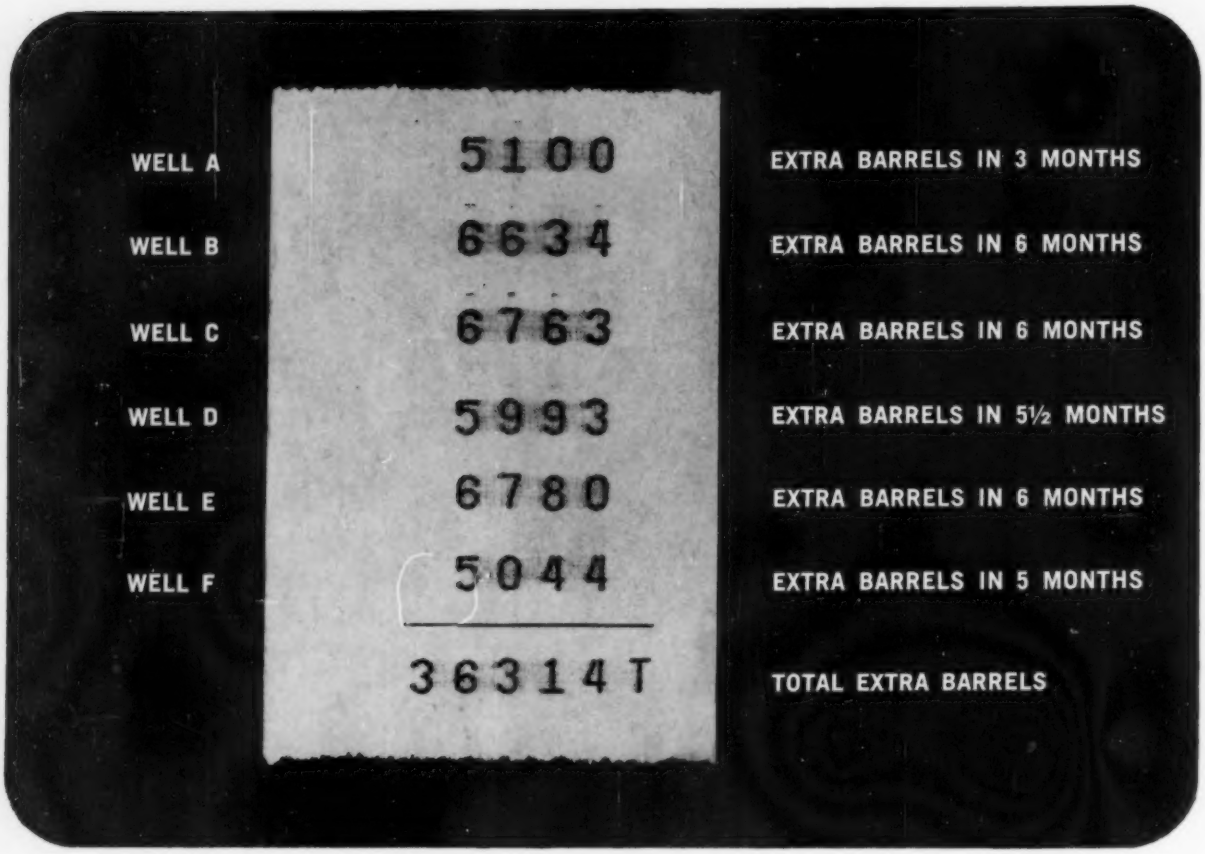
could you use production increases like these?



This operator got 36,314 barrels of extra oil from six wells within six months after they were fractured by Dowell. Total service costs for the six treatments averaged only $2931.79 per well. The extra oil produced during the first six months, as a result of fracturing, cost less than 49 cents per barrel. Additional production after the first six months will be almost clear profit.

All six wells, in Manitoba, Canada, were treated by Dowell at about the same time. All were given similar treatments in which 50,000 pounds of 20-40 mesh sand, at 2-3 pounds per gallon of lease oil, were injected into the pay zone at about 40 bpm. The production gain was determined for each well by comparing total production for equal periods immediately before and after treatment. Production periods were six months for three of the wells. Records for the other three wells covered 5½, 5 and 3 months, both before and after treatment.

Your production problem may be different from the one faced by this operator. The chances are good, however, that Dowell engineers can design a treating program to help you produce more oil at less cost per barrel.

For service or more information . . . call Dowell. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma.

SERVICES FOR THE OIL INDUSTRY — DOWELL — DIVISION OF THE DOW CHEMICAL COMPANY

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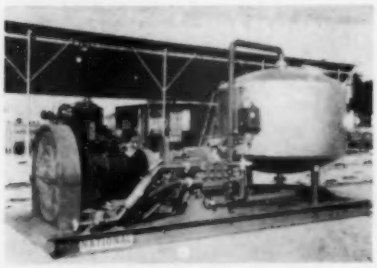
Gas-Engine Powered Packaged Water Flood Unit



A compact, packaged waterflood unit has been built by National Supply that uses gas-engine power. Skid-mounted unit is built around their new J-50 Triplex pump and it was direct-connected to a slow-speed gas engine. Pump capacity can be varied from a maximum of 4480 bbl per day at 560 psi, to 1530 bbl per day at 1645 psi. A 9½-in. by 12-in. single cylinder, two-cycle engine is direct-connected by a flexible coupling to the pump and drives a centrifugal 600-gpm backwash pump and 150-gpm transfer or filter pump by means of V-belt drives from the engine clutch shaft and pump shaft extension. *National Supply Division.*

Circle number (17) on reply card.

Cementing Valves

Larkin Packer Company has added an insert type float valve and an insert type circulating valve to its line of primary cementing equipment. Float valve is equipped with a flapper valve and is designed for use when a conventional float collar is not necessary. Circulating valve is similar in design to the valve contained in standard Larkin circulating cementing equipment. Valves are of drillable aluminum alloy. *Larkin Packer Company, Inc.*

Circle number (18) on reply card.

Emergency Annulus Valve

Surface-controlled annulus valve for emergency shut-off on dual completions has been engineered by Page Oil Tool. Where casing annulus is employed as a flow conductor, valve can be installed in tubing 200 ft below the well head. Slips can be set by pressuring tubing string at surface, enabling packer element to load. Packer and piston exposed outside to surface-controlled pressure and inside to flowing pressure. During emergency, pressure is vented through various conventional systems and well pressure closed valve. A closing spring is available for low pressure wells. *Page Oil Tools, Inc.*

Circle number (19) on reply card.

100 HP Air Compressor Delivers Over 500 CFM

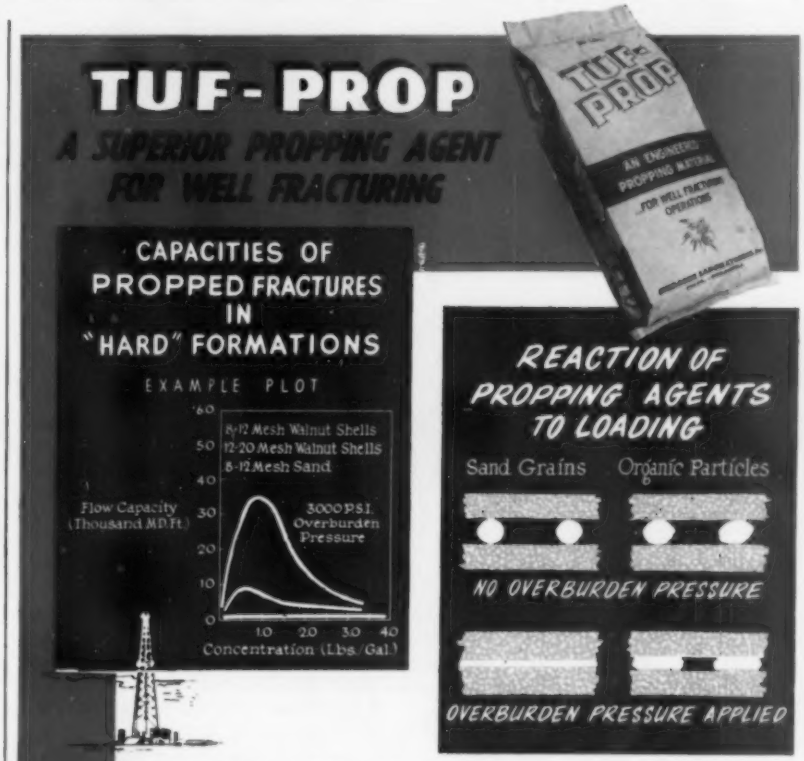
A 100 hp stationary air compressor designed to deliver from 509 to 565 cu ft per min at pressures ranging up to 125 psi can be mounted on bonded rubber for semi-portable installations. Designated DT4, machine can be fitted with a control system for fully automatic operation. A modern, short stroke, two-stage, double acting, fully air-cooled compressor, the DT4 has a high capacity-to-weight ratio. Equipped with air-cooled intercooler, machine is rated for a working pressure up to 124 psi. Annular valves with large effective-flow area, placed in cylinder head, permits large valve area, resulting in low air velocity, smaller pressure drop, and lower working temperatures. Unit has two separate lubrication systems, one for all bearings and one for cylinders. Both systems acquire oil from crankcase oil sump, eliminating daily filling and enabling unit to operate for two weeks before requiring additional oil. Output is 509 cfm at 100 psi when running at 870 rpm and 565 cfm at 100 psi when running at 970 rpm. *Atlas Copco, Inc.*

Circle number (20) on reply card.

Mud Pump Modified

New features have been added to 500 hp, 14-in. stroke mud pump of Gardner-Denver GX line. A cast steel fluid end has been adopted as standard equipment complete with threaded valve covers and new threaded cylinder heads. Optional alloy iron cylinders and bolted-type valve covers are available. Another added value is counterbalanced eccentric for smoother performance. Pump is designed for high pressure drilling and deep hole requirements. *Gardner-Denver Company.*

Circle number (21) on reply card



Laboratory and field applications have shown that carrying capacities of hydraulically induced fractures can be materially increased in many cases through the use of rounded walnut shells as a propping agent. These applications show that TUF-PROP (rounded walnut shells) is superior to sand as a propping agent in formations of such hardness or high overburden that will cause the crushing of sand.

With TUF-PROP you may expect these advantages:

1. Greatly increased permeability of propped fractures in "hard-rock" formations.
2. Greater radius of propped fracture with no increase in volume of fracturing fluid.
3. Reduction of time required for bottom-hole cleanup after fracturing job.
4. Elimination of abrasion by propping agent on bottom-hole and surface equipment if "flow-back" occurs.
5. Walnut shells are practically inert to reactions of oil, water and acids.
6. TUF-PROP is easier to pump, is only half the weight of sand.

TUF-PROP rounded walnut shells are available in three standard mesh sizes: 8-12 mesh, 12-20 mesh, and 20-40 mesh.

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ODESSA • MIDLAND • McALLEN • CORPUS CHRISTI • HOUSTON • DeQUINCY • LAFAYETTE • NEW ORLEANS

EXPLORATION ACTIVITIES

AUSTRALIA

Exploration Group Formed To Explore 29 MM Acres

Three oil companies have combined their Australian interests to form United Australian Oil Ltd., which will conduct exploratory work. Concession acreage formerly held individually by Texas American Oil Corporation, Landa Oil Company, and Nortex Oil and Gas Corporation was pooled to form 28,000,000 acres. This lies in Queensland, Northern Territory, and New South Wales.

United Australian will drill its first test this spring on a 12,000,000 acre grant in Queensland to a depth of 5000 ft.

ADEN

Rights on 5000 Acres Open in Thamoed Region

Oil exploration and exploitation opportunities remain open for concession in some 5000 sq miles of Thamoed region in Hadhramut of the Aden Protectorate. Two sultans making their tribal areas available previously had tract under concession to a British company, U. S. Department of Commerce in Washington D. C. reports.

IRAN

Pazanun Gas Field Yields First Oil From 9080 Ft

Iranian Oil Exploration and Producing Company has found the first oil in their Pazanun field. Well No. 5A entered oil-productive Asmari limestone at 9080 ft, deepening of this well and possibly drilling of another well in vicinity will determine extent of production. Well lies on pipeline route from Cachsaran to Bandar Mashur.

Preparations are being made to drill exploration well Lavan No. 1 on Sheik Shuaib Island on Straits of Hormuz upon completion of Suru No. 1 at Bandar Abbas, which has reached a record depth for Iran of 14,895 ft. Another well will be drilled at Bibi Hakimeh about 30 miles south of Gachsaran.

KUWAIT

Seismic Survey Commenced On 1500 Sq Miles Offshore

A seismic survey has begun on 1500 sq miles on an offshore tract near Kuwait, and it should be completed early this summer. Full interpretation of information obtained will take six or seven additional months, then a drilling location will be chosen and first well spudded early next year.

Formal agreement on exploration and production rights has been signed by Emir of Kuwait and F. J. Stephens, a managing director of Royal Dutch Shell Group.

LIBYA

Discovery Flows 2250 Bpd On ½-in. Choke Test

Controlled production testing has begun on Esso Sirte, Inc.'s Ragub-1 discovery well in concession 20 in Cyrenaica province of Libya.

Ragub-1 well has a 220 ft gas and oil bearing section below a depth of 5280 ft. Initial test data obtained from 40-ft perforated section, 5440 to 5480 resulted in production rates of 494 bbl 40.5 deg API oil per day through a ¼-in. choke and 2250 bbl per day through a ½-in. choke.

Testing is being continued at higher rates from this new discovery, which Esso Sirte terms "significant," and company is confident that production rates can be increased to 5000 bbl per day by opening additional section and using acidization.

Esso Sirte has moved a second drilling rig into area, and two additional wells are presently being drilled to determine areal extent of field. It is located in southeastern portion of Concession 20, about 80 miles from the Mediterranean coast.

An affiliate company of Standard Oil Company of New Jersey, Esso Sirte serves as operator of the concession which is owned jointly with Libyan American Oil Company and W. R. Grace and Company.

TEXAS

Significant Abo Reef Well Discovered in Gaines County

A significant oil discovery has been brought in from a wildcat well completed in Abo Reef formation in Gaines County, Texas. This first substantial strike in an Abo formation outside of New Mexico pumped 137 bpd of 38.8 deg gravity crude at a depth of 8080 ft.

Wildcat Gas Well Tests 37 MMcfd in Matagorda County

A rank wildcat gas-condensate discovery in Matagorda, Texas, tested at an absolute open flow of 37,774,000 cu ft gas per day with an average yield of 24.3 bbl of condensate per million cu ft. Tennessee Gas Transmission Company brought in the 1 Willie Doss, three miles south of Wadsworth field. Flow is from perforations in Lower Frio formation at 12,196 to 12,205 ft. Production is indicated in two other intervals of Middle and Lower Frio formations, but they have not been perforated.

Tennessee Gas drilled well to a total depth of 13,448 ft, but it was plugged back to 12,324 ft.

Pay Opener Final-Tests For 14 MMcf on Open Flow

Gulf Oil Corporation completed a pay opener which finaled for a calculated absolute open flow potential of 14 MMcfd from perforations at 7388 to 7408 ft in South Monahans gas field. No. 505 Hutchings Stock Association well opened the field to production in Ward County. Well is located 1¾-miles south of Monahans, Texas in section 53, block N, G&MMB&A survey.

Wildcat in Andrews County Flows 375 Bpd at 13,900 Ft

A wildcat into Ellenburger formation of McFarland field in Andrews County, Texas finaled for a daily potential of 375.19 bbl of 45.6-gravity oil, flowing through a 15/64-in. choke and perforations at 13,898 from 13,900 ft.

Texaco, Inc. owns well, which is located seven miles northeast of Andrews in section 32, block 3, University Lands survey.

LOUISIANA

Gas Found on Lease From Last Federal Sale

First discovery on offshore Gulf of Mexico leases acquired at federal sale last year is being completed in a high pressure gas-condensate sand interval at 14,859 ft.

Union Oil Company of California owns half-interest in the well on a 5000-acre Block 209, the Northwest Lac-Blanc Prospect in Vermilion Parish, Louisiana.

WISCONSIN

Shallow Tests Suspended After Finding No Shows

Drilling operations in Southeastern Wisconsin have been suspended after

four shallow tests to 700 ft and one test to 1500 ft yielded no shows.

Texas-Wisconsin Exploration Company based hopes on gravity surveys of western shore of Lake Michigan in Sheboygan County, Wisconsin. Drilled with a rotary rig, tests may be resumed during the spring.

VENEZUELA

Government-Owned Company Plans Tests in Maracaibo

New national oil company in Venezuela has announced plans to start drilling operations in Lake Maracaibo before mid-year.

Venezuelan Petroleum Corporation (CVP), intends to drill on offset well to existing production on blocks held by private operators.

A drilling contractor will drill this first well, located on a 332,940-acre concession in the mid-lake area. Semi-proved acreage, the L-shaped tract was granted to CVP by their government last year. It includes National Reserve Blocks 71, 74, V-580, and open acreage.

CALIFORNIA

Companies Submit No Bids On 4250 Acres Offshore

Oil companies submitted no bids on a 4250-acre tract off Santa Barbara County, California. State officials put this lease up for bidding last month, the first offering since July, 1958.

Tract offered, known as Parcel 1, is adjacent to a block now being developed by a group headed by Phillips Petroleum Company.

However, more interest should be shown when bids are announced this month on Parcel 2, a 4250-acre block adjacent to Phillips block and two miles west of Parcel D, which is being developed by Texaco Inc. as operator with two partners. Parcel D brought $23,711,538 in 1958.

Big factor in lack of bids on Parcel 1 is that acreage's nearness to Pacific Missile Range, which the U. S. Navy is trying to expand. Shipping lanes cross the parcel also and may present problems in locating a platform.

KENTUCKY

Lewis County Wildcat Fails To Find Production

A wildcat in eastern Kentucky has been plugged and abandoned after failing to find production. R. G. Howes has abandoned 1 Goldie Gilliam in Lewis County at 1070 ft.

Test encountered Berea (Mississippian sand) at 165 ft, Devonian black shale at 840 ft, and Corniferous limestone at 1055 ft.

moment of truth

Nothing spells out the truth about a formation straighter than *Core Analysis.*

And while other exploration services end on the derrick floor, the utility of *Core Analysis* goes on and on. Long after you have applied this *direct* down-hole information to immediate drilling, testing, and completion decisions, you'll find its availability a virtual windfall through development, financing, and optimum depletion practices.

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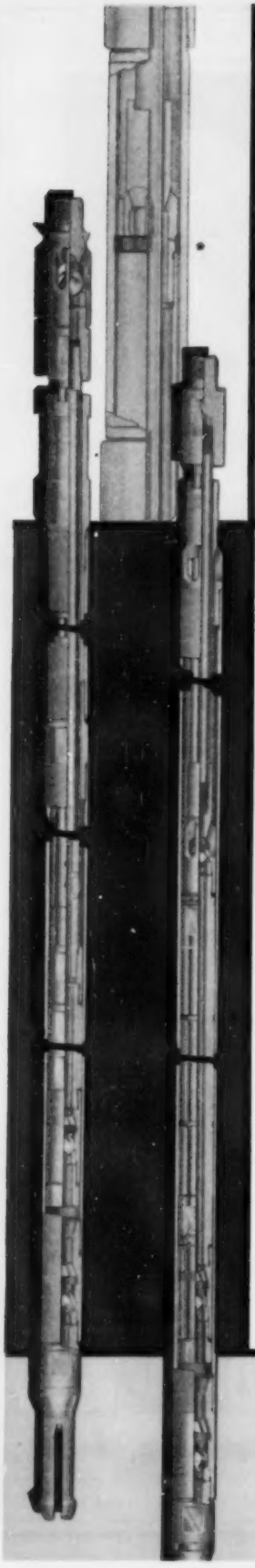

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oilmaster "Slim Hole" PUMPS

. . . for sandy wells to eliminate the sanding-in hazard of bottom anchoring a 1" bore pump in 1¼" tubing. The top of this unique Slim Hole Pump is fitted with a brass ring. When the pump is seated the brass ring is pressed into a sealing nipple properly spaced above the shoe in the tubing string. This prevents sanding-in by sealing the pump-tubing annulus . . . another problem solved with one of the many combinations developed by OILMASTER for Slim Hole completions.

The dependable basic features long characteristic of standard size OILMASTER pumps are built into all OILMASTER Slim Hole Pumps. Even gassy wells are no problem . . . Oilmaster's Slim Hole Pump is available in Ratio-Compound as well as Conventional design . . . for both 1¼" and 1½" tubing.

The development of an economic and dependable means of producing a slim hole completion is more of how OILMASTER works for you. Your OILMASTER or National Supply representative can give you all the details . . . or contact these co-distributors: **Beacon Supply Company, Dominion Oilfields Supply Company, Limited, Industrial Supply Company, Union Supply Company. For other literature write to FLUID PACKED PUMP, 9100 S. Norwalk Blvd., Los Nietos, Calif.**

ARMCO National Supply Division

RUNNING TOUR with

▸ The AIME elected **Carl E. Reistle Jr.,** executive vice president of Humble Oil & Refining Company and a former AIME president, to an honorary membership. **William S. Davis,** of Humble, has been named chairman of the Permian Basin Section. **Edwin O. Bennett** was awarded AIME's Anthony F. Lucas Gold Medal for his development of many production techniques for use of gas energy for oil recovery along with new type well completions methods.

▸ **Louis F. Davis** became assistant general manager of The Atlantic Refining Company's domestic producing department on February 1.

▸ The California Research Corporation promoted **A. W. Pryor** to senior research engineer, in process and plant design in the Richmond Laboratory.

▸ **Sam G. Gary** was elected president and chief executive officer of Core Laboratories-Canada, Ltd.

▸ Cosden Petroleum Corporation has named **H. L. Weeks** superintendent of production.

▸ **John C. Bayless** has joined the firm of Doeringsfeld, Amuedo and Ivey, Consulting Geologists as manager-engineering geology operations.

▸ Earlougher Engineering of Tulsa announced that **Charles S. Larkey** has joined the staff as consultant, setting up additional machine applications in the data processing department.

▸ **Louis W. Gardner** has been appointed director of the geophysical research division of Gulf Research and Development Company; and **Robert E. Zinkham** has joined the production engineering division.

▸ **Samuel E. Charlton** was named assistant manager of the Oklahoma-Pate area of Humble Oil & Refining Company.

▸ The directors of the International Oil Scouts Association installed **Ronald York,** scout for the Sun Oil Company in Corpus Christi, as president for the year 1961.

▸ Kerr-McGee Oil Industries, Inc. announced a number of personnel changes: **Charles F. Miller,** foreign and domestic general production manager; **George B. Parks,** vice president, oil and gas exploration; **Grier D. Zimmerman,** general manager of foreign and domestic drilling operations; **Leo P. LeBron,** manager of foreign drilling.

▸ Lion Oil Company named **Gene L. Shaw** regional geologist for the Rocky Mountain region; and **Leslie L. Greenfield,** district geologist, Southern region.

▸ **Glen F. Johnson** of Mobil Oil Company, was named exploration superintendent of the Wichita district, succeeding **A. D. McRae,** who becomes exploration superintendent of the Midland office.

▸ The Oil Recovery Corporation of New York and Tulsa opened a new district office in Midland with **Robert E. Chandler,** district engineer in charge.

▸ **Harold Overton** of the University of Houston has been commissioned to establish a Petroleum Engineering Department in the Bandung Technological Institute in Java.

▸ **Lewis C. Holder** joined Trunkline Gas Company as Houston district landman.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

MEN in the INDUSTRY

William J. Rogers has been named chief petroleum engineer in the production department of Sinclair Oil & Gas Company, Tulsa, succeeding **Lloyd Holsapple,** who was named manager of the unitization and part interest department. **Coles S. Tinkler** moved to Denver as superintendent of the exploration department.

Thomas E. McDowell has joined the 25 Rig French contract drilling company, Societe Languedocienne de Fore Forages Petroliers, coordinator of foreign contracts and operations.

Thomas P. Simpson, general manager of engineering and operations analysis, has retired after 35 years' service with Socony Mobil Oil Company, Inc.

Roger W. Stoneburner was named manager of exploration of Southern Natural Gas Company.

Standard Oil Company (New Jersey) announced the election of **Paul N. Temple** as president of Esso Iberia, Inc., Standard's Spanish exploration affiliate.

W. E. Stiles Engineering, Inc., Tulsa, has signed a contract with PETROREP of Paris, France, to provide full time engineering and supervision of PETROREP's drilling, completion and producing operations. **Raymond O. Courtright Jr.,** has been named to handle the PETROREP assignment.

At Sun Oil Company, **Francis E. Heath,** retired after 42 years as chief geologist in the Southwest production division, and was succeeded by **Robert E. Rettger.**

Sunray Mid-Continent Oil Company's production department in Tulsa announced two staff changes; **Oran A. Graybeal,** appointed administrative assistant to **R. E. Foss,** senior vice president—production; **Gorder E. Hillhouse,** manager of engineering for production, succeeding **L. G. Rodgers,** who was named vice president of Sunray Chemical Company.

James G. McDaniel has joined Tears Engineers, as project engineer. McDaniel was formerly manager of the Beaumont engineering division of Socony Mobil Oil Company.

John N. Troxell, general manager of the domestic producing department of Texaco Inc. in Houston, retired after 38 years' service.

L. T. Sloan was appointed assistant manager of the Texas Gas Transmission Corporation's Louisiana division. **Jay S. Handley** was elected vice president in charge of drilling and production.

J. D. McMahan of Mobil Oil Company is the new president of the Texas Gulf Coast Oil Scouts Association. **Nick Angelos** of Union Producing Company is the bull scout for the 1961 scout check.

Union Oil Company of California made its Midland office headquarters for the central division extending from the Rio Grande River to the Canadian border. The division offices at Tulsa and Denver are being abolished and will be supervised from Midland. **C. F. Bowden** became division manager in Midland, succeeding **Ray A. Burke,** who was named director of exploration for the domestic operations of the company.

S. J. Remaklus, safety supervisor of The Ohio Oil Company's Tulsa production division, will retire after 33 years' service with the company.

L. A. Sunkel, vice president of The Atlantic Refining Company, has retired after 42 years of service that ranged from junior clerk in the producing department to vice president and general manager in charge of foreign and domestic production.

At Continental Oil Company, **C. E. Greenwood** has been named manager of the land section.

Charles B. Worst has resigned as superintendent of production in Amarillo for the Natural Gas Pipeline Company of America and will be replaced by **Walter B. Verner.**

E. H. Burtner has assumed the duties of division exploration superintendent of Northwestern division in Amarillo for Standard Oil Company of Texas, while **C. R. Hensch,** former superintendent of the division, assumed the duties of assistant to the vice president (administrative) in Houston, the position formerly held by Burtner.

James B. Taylor has been appointed general manager of Signal Oil and Gas Company's gas department. In the general reorganization of the department, **Paul Chambers** moves to Los Angeles to become assistant to the general manager, **R. L. Cook** has been appointed manager of operations, **Harvey Menard** was named manager of joint interests, and **David R. Arnold** is manager of engineering and construction.

Target **Longer Service**

TYPE 30 — Carbon-Manganese fully normalized. For heavy duty where corrosion is not a major problem.

TYPE 75 — Nickel-Chromium-Molybdenum Steel, normalized and tempered. For extremely heavy duty in medium corrosive fluids.

TYPE 40 — Nickel-Molybdenum Alloy. Normalized and tempered. For heavy duty pumping in medium corrosive conditions.

TYPE 78 — Carbon-Chromium-Molybdenum Boron Alloy, normalized and tempered. For heavy duty pumping in non-corrosive or inhibited fluids.

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New Literature

Sound-Powered Telephone

Voice of user supplies all power needed to operate USI Sound Powered Telephones. No batteries or power connections are used. Transmission of 30 miles or more, using proper-sized wire, can be obtained under normal conditions. Telephones, stations, and accessories are described in an eight page, two-color brochure. *United States Instrument Corporation.*

Circle number (22) on reply card.

Waterflood Valve Line

An eight-page, two color Catalog 14-J1 issued by Edward Valves describes their expanded waterflood line, which includes globe valves, check valves, resilient-seat gate valves, gage valves, and strainers in sizes from ¼ to 4-in. Plastic coating on most commonly-used valves and strainers is described, and publication has complete tables of specification and includes cut-away drawings showing valve interior details. *Edward Valves, Inc.*

Circle number (23) on reply card.

Filter Regulator

Rockwell's "080" Filter Regulator is described in a two-page bulletin. Filter regulator is applicable wherever a controlled supply of clean air or gas is needed. Constructed of pressure die cast aluminum, regulator has a maximum inlet pressure of 250 psi and outlet pressure ranges of 0 to 5, 5 to 35, and 35 to 100 psi. Bulletin includes typical performance curve, construction specifications, and a cut-away drawing. *Rockwell Manufacturing Company.*

Circle number (24) on reply card.

Base Station Two-Way Radio

General Electric Company has issued Bulletin ECR-816 on company's table model base station two-way radio. Unit features compact styling and may be installed on a desk, cabinet, shelf or table. It serves as a control center permitting a dispatcher or office secretary to talk to mobile radios in cars, trucks, shoulder-strap portables, or shirt-pocket message receivers. Up to 60 watts of power available, with additional power up to 250 and 330 watts obtainable through using a high power amplifier. *General Electric Company.*

Circle number (25) on reply card.

Oil Base Mud Handbook

Information on Black Magic oil base mud and related subjects are presented in 76-page, pocket-size handbook. Included are mixing formulas, treatment, test procedures, description of additives, and instructions for care and handling of oil base drilling fluids and applications where oil base mud is most suitable. Handbook describes these muds mixed with crude oil, emulsifiers, non-fluorescing mixing oil, lost-circulation material, and related products. It contains other data such as sizes and capacities of casing, drill pipe, capacities of mud pits and tanks, volume and height filled for various diameters, pump capacities, and other data. *Oil Base, Inc.*

Circle number (26) on reply card.

Curtailing Waterfloods

Interstate Oil Compact Commission has published a report entitled "A Study of Effect of Curtailment of Production on Recovery from Waterfloods and Other Secondary Recovery Projects." Report contains papers presented before a subcommittee of secondary recovery and pressure maintenance committee during three meetings, together with comments on these subjects. *Interstate Oil Compact Commission.*

Circle number (27) on reply card.

Auxiliary Drawworks Drive

Drilling operations with National Auxiliary Drawworks Drive are graphically illustrated and explained in Bulletin No. 521, issued by National Supply. An eight-page bulletin shows how full power of all engines in a compounded drive group can be utilized in driving pumps while varying rotary speed (independently of pump speed) without separating front engine from others. Controlling drawworks and rotary with soft drive provided by hydraulic coupling is discussed. Two models are presented in bulletin, one for National drive groups, and another for different makes. *National Supply Division.*

Circle number (28) on reply card.

Liquid Level Gage

A bulletin on Varec Figure No. 8400 Series high-pressure Dynamatic liquid level gage is now available. Operation and unique features of this electrically-powered tank gage, which is calibrated to 1/16-in. is explained in this four-page bulletin. Gage uses a displacer instead of a float. *The Vapor Recovery Systems Company.*

Circle number (29) on reply card.

MUD BILL SLASHED
$12,000.00

"WE ATTRIBUTE ALL GOOD RESULTS ON NUMBER TWO WELL TO PHENO-SEAL"

verbatim quote by mud engineer

WELL #1

In Galveston County, Texas, a major producing company drilled a virtually trouble-free well. 453 bags of lost circulation material used, of which Pheno-Seal comprised 42%. Mud weight reached 17.4 at TD or 15,200 ft. Production string set and well completed without trouble. Conclusion — exclusive Pheno-Seal trial definitely warranted.

WELL #2

Three miles away, same company went to 100% Pheno-Seal. Mud weight reached 17.9 at TD or 15,500 ft. No trouble logging, including wire line. Ran pipe no trouble. Less protection pipe, higher mud weight and greater depth in same formation as #1. 31% less lost circulation material used. Mud bill reduced over $12,000.00.

FIELD-PROVEN PHENO-SEAL

- Non-Fluorescing
- Will not harm pumps and valves
- 35,000 P. S. I. compressive strength
- Chemically inert — unaffected by temperatures, acids and alkalies
- Reduces friction
- Mixes easily with all types of muds
- Available through your mud dealer.

PHENO-SEAL

A 12-page brochure on Pheno-Seal is available at your request. Just write . . .

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- Smooth gripping members hydraulically actuated
- No slips to replace
- Completely automatic
- Calibrated holding power
- No bleeder valve required
- Large by-pass area
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- Simple construction, minimum maintenance
- Installed above pump; automatically "sets," holding tubing in natural tension
- No drag on casing going in hole or coming out unless tubing is pulled "wet"
- Can safely be installed in perforated pipe

Compensates both up and down

Complete range of sizes for 4½" to 11¾" API Casing. Write for complete information.

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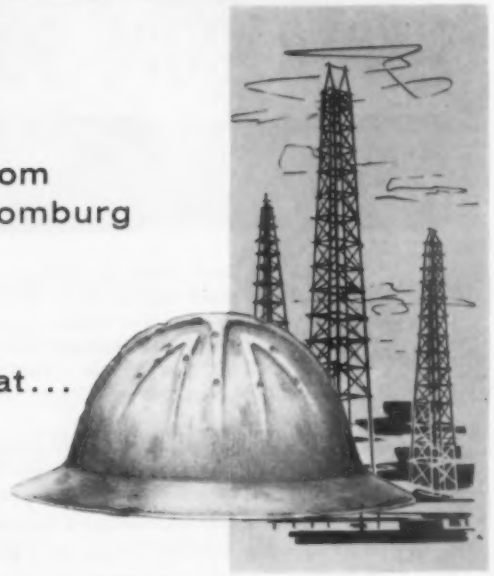

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Pioneers in the field of Military and Industrial Communications.

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Charts for Valve Sizing

How to size OPW-Jordan's Sliding Gate Regulators and Control Valves is shown in four-page Sizing Chart bulletin JSC-1. Simplified charts cover steam, liquid, and gas service and cross-reference method of compiling makes sizing easy by eliminating need for rulers, formulas, or slide rules. Technical data (applying to all makes of valves) tells how to adjust sizing for variations in pressure, temperature, viscosity or specific gravity. *OPW-Jordan Corporation.*

Circle number (30) on reply card.

Milling Packers, Plugs, Couplings As Collars

Two Baker bulletins have just been released. Bulletin 382 shows how newly-developed insert valves can be made-up in casing couplings as an economical substitute for conventional cement collars. Valves are available in either floating or fill-up models, and company recommends them for moderate depths. Bulletin 383 describes how mill-over of a production packer is performed by carbide compound used on Baker milling tools. *Baker Oil Tools, Inc.*

Circle number (31) on reply card.

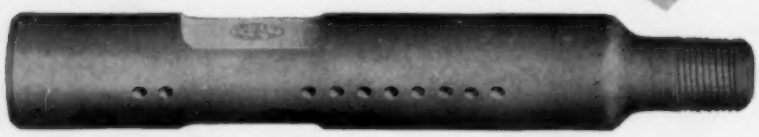
X-Ray Spectrograph

A four-page folder titled "Gulf's New 100 KV X-Ray Spectrograph," giving details on new X-ray analytical methods for use on lubricating oils, crudes, distillates, residuals, and other uses is available. Illustrated with photos and graphs, article covers central control, sample preparation, sample cells, and how method works. *Philips Electronic Instruments.*

Circle number (32) on reply card.

Only **SPANG** can give you the best in *Strength, Service, Economy and Footage* in a Prosser-type

SWIVEL ROPE SOCKET



There are times when an ordinary rope socket will meet your needs. But there are too many times when you can't afford to risk trouble—when you require a rope socket that's precision made and utterly dependable under all conditions. This is the time you'll be glad to have a Spang Rope Socket on the business end of your string—

. . . AND HERE'S WHY SPANG'S BEST

■ Completely Heat-Treated for maximum toughness and hardness ■ Precision machined ■ High steel strength ■ Extra strong joint ■ Carefully finished inside bore ■ Perfect setting for cable ■ Socket neck grooved for the use of fishing tools ■ Made by the country's oldest and largest manufacturer of cable tools

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For over 60 years Manufacturers of Spang Weldless Jars and a Complete Line of Cable System Drilling and Fishing Tools for Oil and Gas Wells, Water Wells, Prospect Drilling and Shot Blast Holes.

Servicing Valves

An eight-page bulletin providing complete instructions for lubricating and servicing Rockwell-Nordstrom valves has been issued. Three-color bulletin describes by text and step-by-step illustrations the proper method of lubrication for all types, correct adjustment of valves, and how to repack Hypreseal valves with plastic stem packing. Chart of recommended lubricants and photos and description of lubricant dispensing equipment is included. *Rockwell Manufacturing Company.*

Circle number (33) on reply card.

Tank Vapor Inverters

Vapor inverters that fit on the pressure relief valve direct fumes and gases, vented from storage tanks as product is pumped in, high into the air, protecting personnel working on tank roofs and surrounding ground areas from exposure to poisonous fumes and gases. Inverters come in 2-in., 3-in., 4-in., 6-in., 8-in., 10-in. and 12-in. sizes to fit these sizes of pressure valves. Data sheet describes device and gives operating instructions. *The Johnston & Jennings Company.*

Circle number (34) on reply card.

Subsurface Recorders

Pressure and temperature instruments for subsurface recording manufactured by V. E. Kuster are described in multi-colored, illustrated, 38-page catalog. Instruments are for wireline and go-devil pressure and temperature surveys. Included in catalog are gauge clocks, micrometer chart readers, fishing tools, supplies and replacement parts. *V. E. Kuster Company.*

Circle number (35) on reply card.

Hydrocarbon Detector

Programmed Hydrocarbon Detector is described in Core Lab's three-color, four-page brochure. Field units can be fully-equipped to provide complete technical aid required for comprehensive well logging service, company states. A sample log comparing different methods is included in brochure. *Core Laboratories, Inc.*

Circle number (36) on reply card.

Products Handling, Waste Disposal

The Dempster-Dumpster system includes several types of equipment which pick-up, haul, and dump detachable tanks or waste containers. Tank containers are available lined with rubber, lead, or highly corrosion-resistant coatings such as polyvinyl chloride plastic and synthetic resins. They are built of steel, aluminum, stain clad or stainless steel. Another special container handles sludge, sticky tars, and semi-liquids. A wide variety of industrial waste-disposal containers also are described in a full-color, illustrated 28-page bulletin. *Dempster Brothers.*

Circle number (37) on reply card.

Magnetically Positioned Jet Perforator

A 1 11/16-in. magnetically positioned jet perforator, capsule type designed to penetrate 2-in. production tubing, is described in Schlumberger's Engineering Report No. 10. Device is designed to give constant perforation quality throughout the producing interval. A magnetic positioning device and high performance charges firing in two directions at a divergence of 120 deg control penetration. *Schlumberger Well Surveying Corporation.*

Circle number (38) on reply card.

"We deliver too"

What's so special about the huge fractionating tower shown here? It is one more example of how Sun Ship builds and delivers heavy industrial equipment on barges or sea-going vessels, with careful attention to such requirements as safety and on-time schedule.

Whether it's a fractionating tower or key structural part for industry, transporting big items by water or by rail is strictly routine for Sun Ship, for we build and deliver what's needed in many fields. If you have a machinery or heavy equipment problem, write to us about it.

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Spotlighting 2 NEW VOGT VALVES

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FORGED STEEL

INSIDE SCREW

Bolted Bonnet

GENERAL GP PURPOSE

GATE and GLOBE

VALVES

150-800 Pounds Service

2000 Pounds Cold, W.O.G.

Available from stock in ¼" thru 2" sizes and in both socket weld and screw ends.

CHECK THESE FEATURES

1. Forged steel pressure containing parts designed for light weight and brute strength.
2. Hard faced seats and hardened discs and wedges.
3. Spiral wound stainless steel or Monel gaskets to suit trim.
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Vogt GENERAL GP PURPOSE Vogt VALVES & FITTINGS **FORGED STEEL VALVES**

construction briefs

Goodrich-Gulf Chemicals, Inc. is beginning construction at Institute, West Virginia, on a multi-million dollar plant to produce 20,000,000 lb per year of Ameripol CB, cis-polybutadiene rubber, the only polybutadiene rubber which can be used as a 100% replacement for natural rubber in heavy duty tire treads.

First commercial application of Houdry's new Detol catalytic dealkylation process will be in a new plant being built by Crown Central Petroleum Corp. Plant is designed to produce 17,000,000 gal of benzene per year. Catalytic Construction Company is handling engineering and construction.

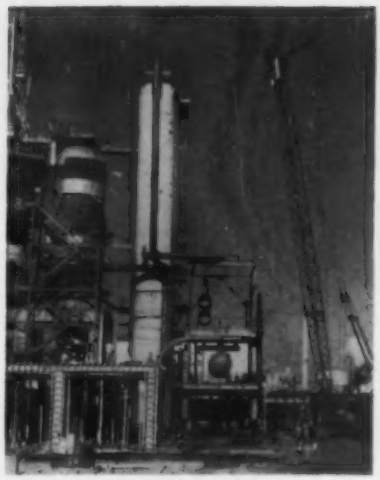
Fish Engineering Corp., Houston, has contract for construction of new gasoline plant in the North Rincon Field, Starr County, Texas, with design capacity of 35 MMcf per day. Plant will be a joint venture, with Shell Oil and Arkansas Fuel Oil Corp. as major participants.

Monsanto Chemical is expanding production of its Texas City, Texas, vinyl chloride monomer plant by 50% to 150,000,000 yearly.

Pure Oil and Atlantic Refining will go in on a 50-50 basis to build a 50,-000,000-gal-per-year aromatics manufacturing unit at Pure's Nederland, Texas, refinery. Unit will produce benzene as main product, supplemented by toluene and styrene.

Celanese Corp. will use a new process licensed by Aldehyd GmbH of West Germany in a new multi-million-dollar plant near Bay City, Texas, to make acetaldehyde and 2-ethyl hexanol. Capacity will be about 100,000,000 lb per year.

Ethylene producing capacity of Enjay Chemical's Bayway, New Jersey, refinery will be expanded by 35% to boost capacity to 175,000,000 lb per year. Increase will raise Enjay's total ethylene producing capacity to approximately 845,000,000 lb per year.



New catalytic cracking unit takes shape as part of Signal Oil and Gas Company's multi-million dollar expansion and modernization program at its Houston division refining and petrochemical complex.

A natural gas processing plant designed to process up to 150 MMcf per day will be built near Port Arthur, Texas, by Port Gas and Processing Co., a division of Hudson Gas and Oil Co. Ethane-propane mixture, butanes, and natural gasoline produced here will be sold to petrochemical plants in the area.

Reichhold Chemicals plans to construct a $10,000,000 plant to produce 50,000,000 lb of vinyl acetate monomer per year. Two sites in the Houston area are being considered.

American Cyanamid will build a plant at Fortier, Louisiana, to make methyl methacrylate plastic using a process licensed by Imperial Chemical Industries, Ltd., of Britain. Cost and capacity were not disclosed.

Mobil Chimica Italiana SpA, newly formed Italian chemical company affiliated with Socony Mobil Oil Company, Inc., will build a major plant at Naples to manufacture benzene, ethylbenzene, orthoxylene, and paraxylene. Initial total yearly out-put will be 39,-000,000 gal, of which more than 75% will be benzene and orthoxylene.

A $70,000,000 petrochemical complex at San Lorenzo, to be built by Petroquimica Argentina, SA (PASA), will supply Argentina's major needs for synthetic rubber, benzene, and chemical intermediates. PASA, an Argentine company, is owned by five major U. S. industrial corporations . . . Cities Service, Continental Oil, U. S. Rubber, Witco Chemical, and Fish International.

India's government has granted licenses for two petrochemical plants in Assam to use natural gas from Assam fields. Approved were licenses to Duncan Bros. to manufacture polystyrene and synthetic rubber in collaboration with Phillips, and PJB Industries for manufacture of carbon black in collaboration with Continental Carbon.

Amoco Australia, new subsidiary of Standard Oil Company (Indiana), plans to construct a refinery near Brisbane with initial crude capacity of 15,-000 bbl a day.

AviSun Corp. and Shin Nippon Chisso Hiryo, KK, Tokyo, have reached agreement to construct a 30,-000,000 - lb - per - year polypropylene plant in Japan.

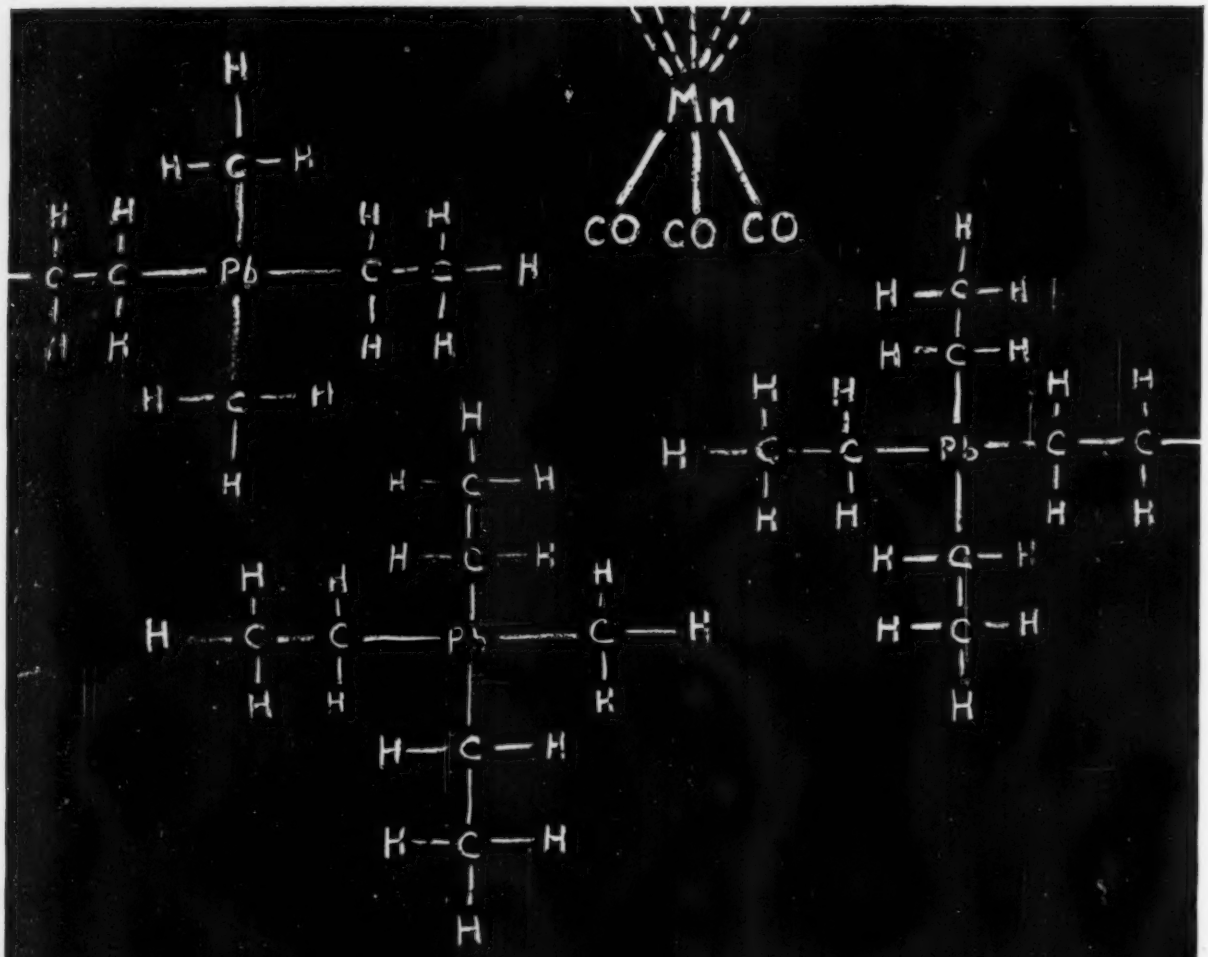
Another expansion of Monsanto's Fawley, England, polyethylene plant will add 50% to the unit's present capacity of more than 17,000 long tons per year.

Main contract for construction of a 30,000,000-gal a year benzene plant, largest in Canada, at Imperial Oil's Sarnia refinery has been awarded to Canadian Bechtel Ltd., Toronto. Estimated cost is $5,000,000.

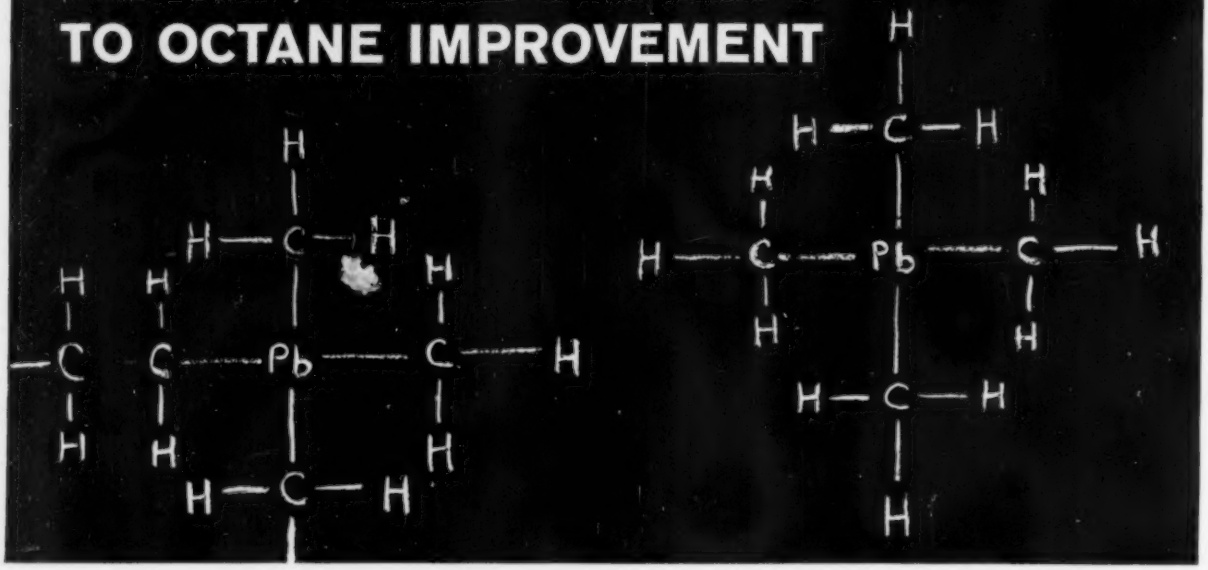
Shin-Etsu Chemical Co. will build a new polyvinyl acetate plant, capitalized at $5,500,000, to turn out 120 tons per month. Plant will be located at Naoetsu on the Japan Sea in Niigata Prefecture.

A $3,000,000 carbon black plant with capacity of 20,000,000 lb per year will be built at Valencia, 75 miles southwest of Caracas, Venezuela, by United Carbon Co. Lummus Co., Houston, has engineering and construction contract.

Imperial Chemical Industries, Ltd., London, has been authorized to invest 5,760,000 pounds in construction of a polyethylene plant in Buenos Aires.



ANTIKNOCKS ADD A NEW FLEXIBILITY TO OCTANE IMPROVEMENT



FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

RECENT DEVELOPMENTS in antiknock compounds have opened new areas for the refiner to consider. Just as raising the allowable limit of TEL concentration provided more latitude, new antiknocks are now available which permit even greater flexibility.

Tetraethyllead

One of the most important developments in the use of TEL came about during 1959—extending the limit to 4 ml per gallon. As a result, the average premium gasoline refined today can be increased from current levels by one and a half Research octane numbers through TEL alone. Similarly the Motor octane number gain is almost two numbers greater. Furthermore, the Road octane gain from TEL is greater than is indicated by either of the laboratory methods.

In the case of regular gasoline, almost two octane numbers can be gained through increasing TEL from present average concentration to 3 ml. The 4th ml of TEL makes possible additional octane improvement.

Tetramethyllead

Research on tetramethyllead—first of a new group of lead alkyls to be offered commercially—shows that in highly aromatic gasolines or in engines prone to induce fuel segregation in the manifold, TML can be considerably more effective than TEL in its road performance.

Mixed Lead Alkyls

Now three more "Ethyl" antiknock compounds are available: MLA 250, MLA 500 and MLA 750—all produced from mixtures of TML and TEL processed to equilibrium composition. Current tests show that these mixed lead alkyls are selective in their ability to provide superior road performance, dependent upon such factors as fuel composition.

Custom Blends

You may find that a physical mixture of TEL and TML in some special ratio is most effective for your needs. Such "custom blends" are available.

Motor 33 Mix

Another compound, Motor 33 Mix—a manganese-lead antiknock—can supply several additional octane numbers when used in certain fuels.

The Future

With this variety of antiknock compounds, each with its particular value and application, maximum flexibility is offered to the refiner. Not only do the antiknocks offer cost savings and delay capital expenditures, but they can provide benefits that cannot be obtained any other way.

REMINDERS TO REFINERS

Antiknocks are your best octane improvement buy, whether costs are figured on Research, Motor or Road ratings.

Antiknocks give you a Road octane bonus you can't get any other way.

Gasoline sensitivity can be decreased with antiknocks.

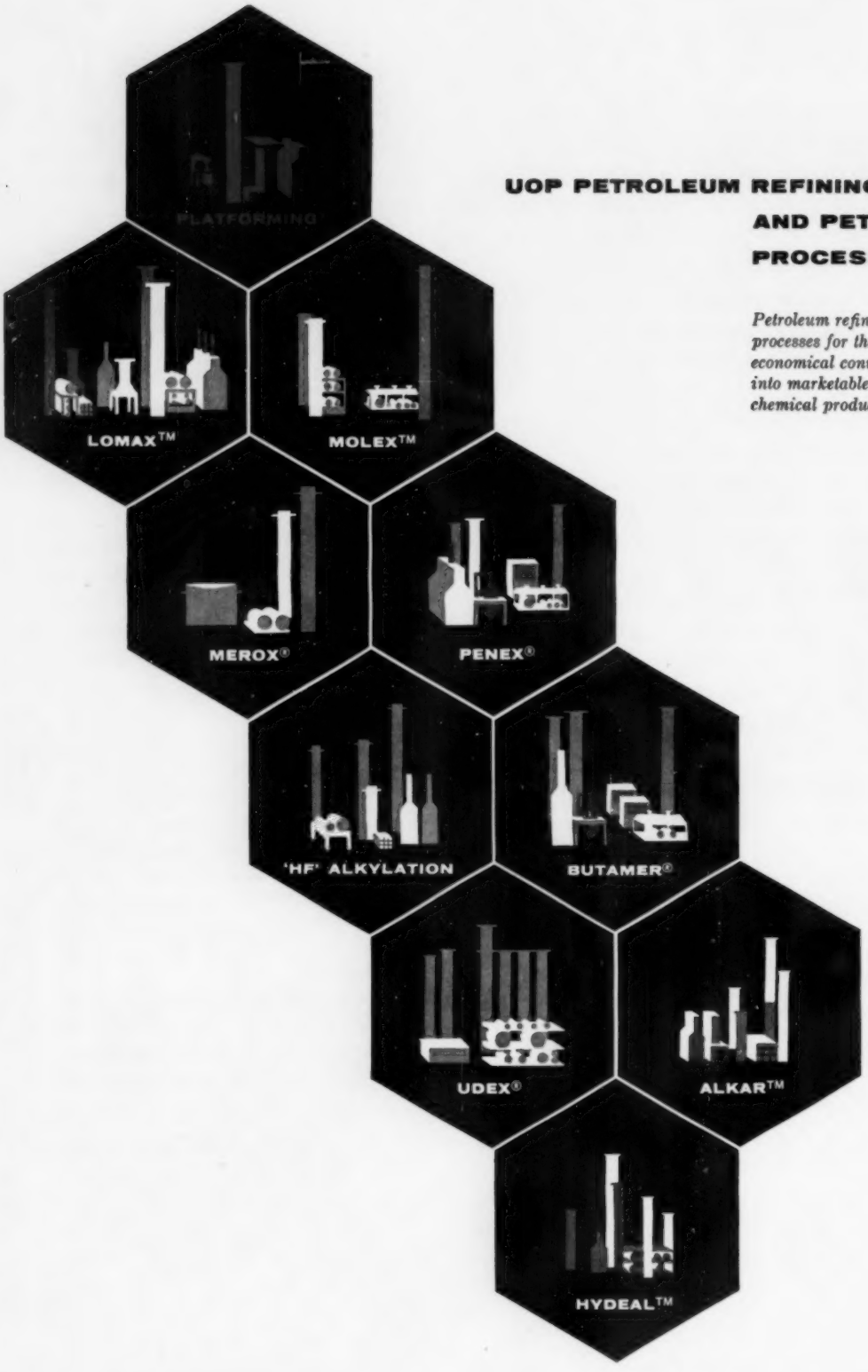
Refining flexibility can be increased with antiknocks.

Antiknocks also can reduce or delay capital investment in octane improvement equipment.

ETHYL ANTIKNOCK COMPOUND — ETHYL CORPORATION

ETHYL CORPORATION, NEW YORK 17, N.Y. • TULSA • CHICAGO • LOS ANGELES

ETHYL CORPORATION OF CANADA LIMITED, TORONTO • **ETHYL USA (EXPORT)** NEW YORK 17, N.Y.



UOP PETROLEUM REFINING AND PETROCHEMICAL PROCESSES

Petroleum refining and petrochemical processes for the efficient and economical conversion of petroleum into marketable fuel and chemical products.

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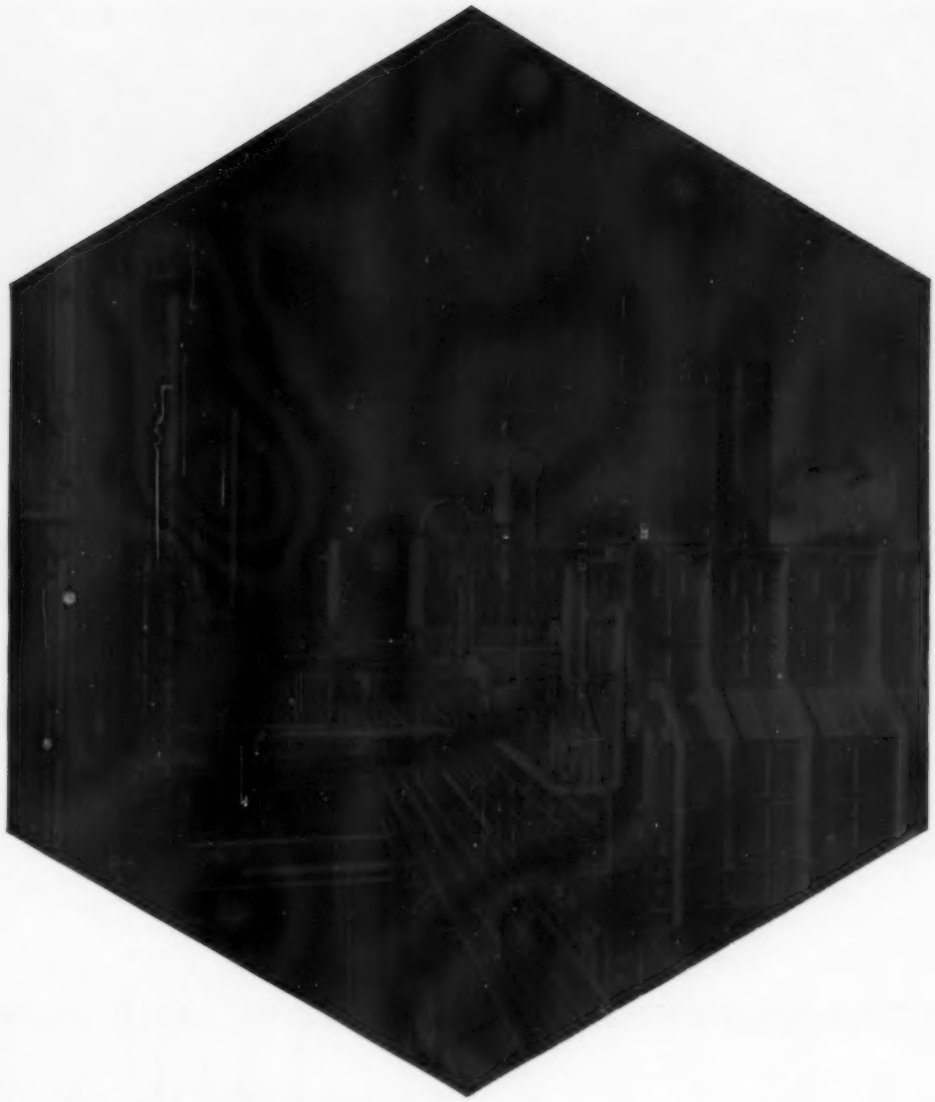

meet the demand for quality gasoline with Platforming

Marketing petroleum products in the sixties promises to be a tight competitive race for quality. Processing will be pushed more and more to produce products that are of top quality, high octane and yet are profitable to produce. Platforming, designed, engineered, and licensed by UOP, produces top quality Platformate for high energy performance.

Now is the time for refiners to evaluate their processing capabilities with the proposed future demand for the better gasoline products. Platforming enables a refiner to make a larger percentage of top quality gasoline and petrochemical intermediates . . . more profitable products.

Platforming is economical to install, reliable and easy to operate. The process utilizes a platinum containing catalyst, that is highly active and hence provides a truly continuous operation. Platforming can handle the full boiling range gasolines without prefractionation, or naphtha cuts separated from them. Any refinery naphtha feed can be processed efficiently by Platforming.

With more than a score of different processes UOP can offer you the most profitable method for either employing your existing facilities or for an entirely new operation. Let UOP engineers evaluate your processing needs now.

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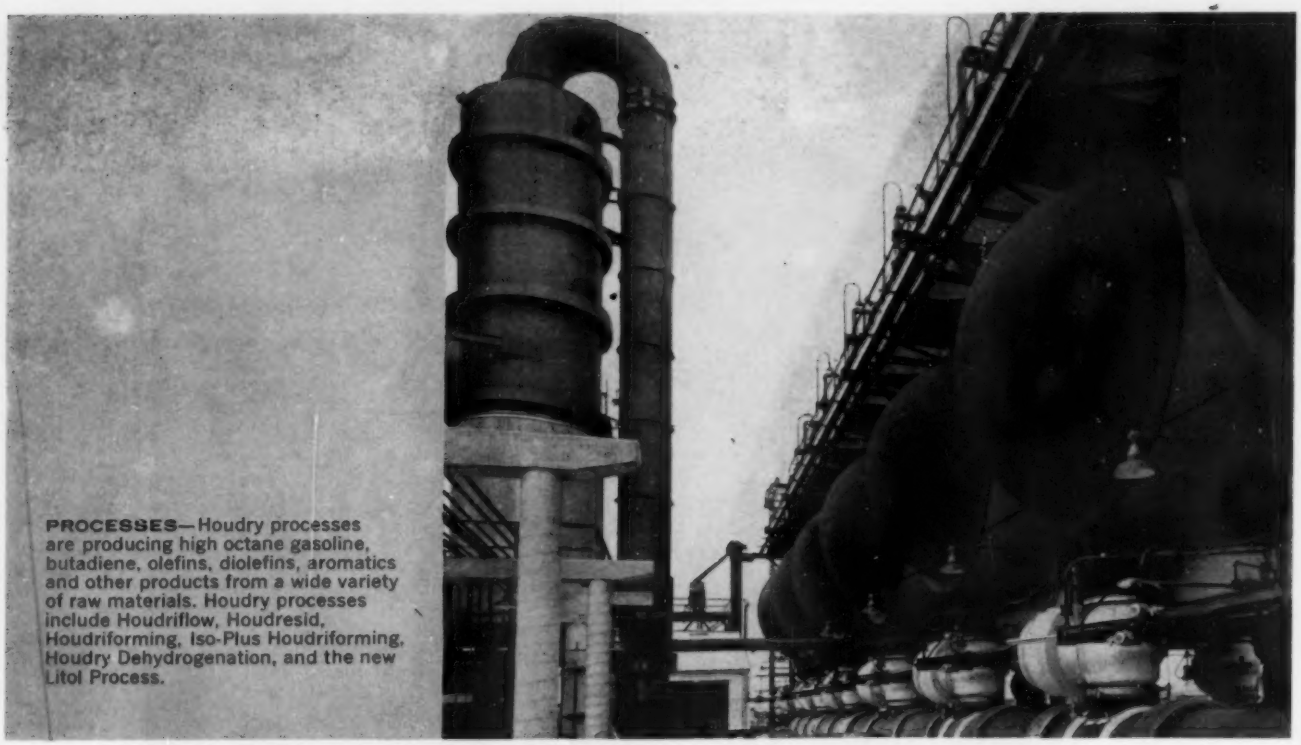
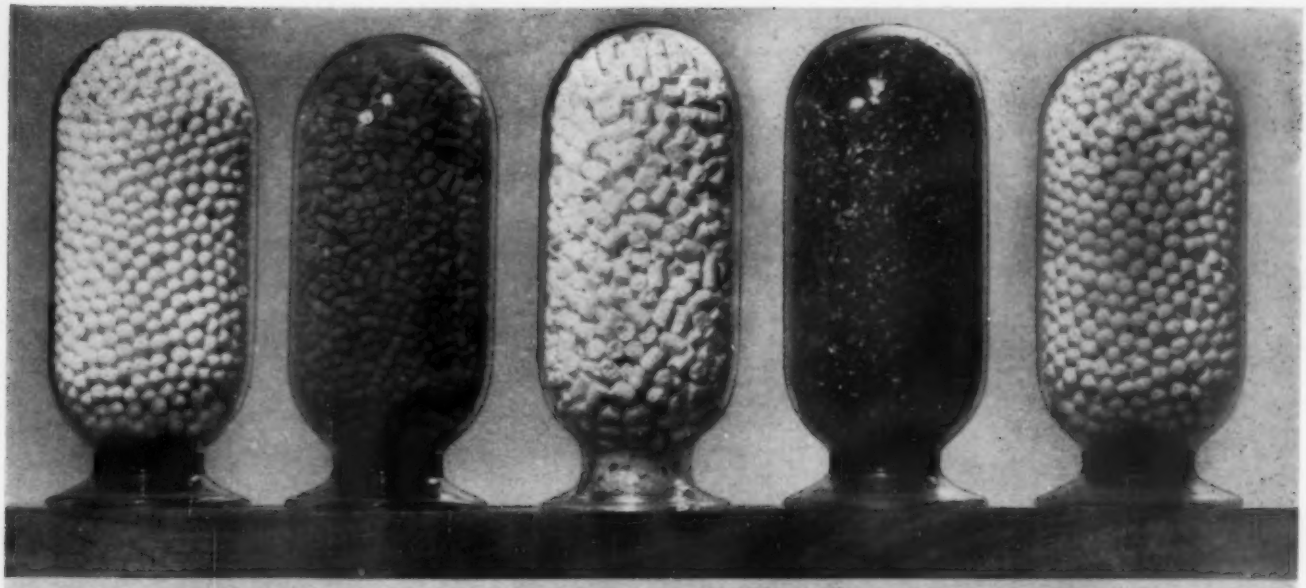


PROCESSES—Houdry processes are producing high octane gasoline, butadiene, olefins, diolefins, aromatics and other products from a wide variety of raw materials. Houdry processes include Houdriflow, Houdresid, Houdriforming, Iso-Plus Houdriforming, Houdry Dehydrogenation, and the new Litol Process.

WHEN THE QUESTION IS CATALYSIS...THE ANSWER IS

CHEMICALS—Developmental work at Houdry has resulted in a number of commercially promising chemicals. They can be generally described as nitrogen containing organic types. More complete descriptions of their properties, typical uses, and possibilities may be obtained on request.



CATALYSTS—Houdry manufactures and supplies a wide range of catalysts for petroleum, petro-chemical and chemical processes. Custom catalysts are also manufactured to order.

HOUDRY

PROCESS CORPORATION

1528 Walnut Street, Philadelphia 2, Pa.

Houdry processes . . . catalysts . . . chemicals . . . services . . . are based on more than 30 years of experience in catalysis. For processors, this extensive experience in different-but-related areas of catalytic processing means unique benefits.

For instance, the catalyst buyer finds—often to his advantage—he is dealing not only with a catalyst manufacturer, but a company fully able to evaluate his process and help him utilize the catalyst more fully than might be possible otherwise.

Likewise, the processor who needs plant-operating assistance finds not only this, but wide experience in engineering and process design, as well.

Houdry process designs are improved by knowledge of catalyst behavior. Services are perfected by experience in continuing research on both processes and catalysts, and so it goes.

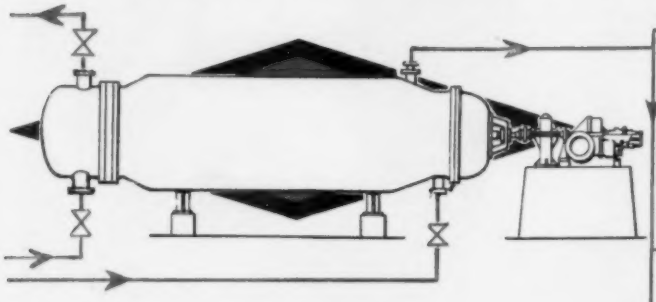
Thus the *total* of Houdry's broad experience adds value to specific Houdry products and services.

Today, as ever, here is proof, that Houdry means Progress . . . through Catalysis.

SERVICES—The wealth of experience Houdry has gained in petroleum and chemical processing is available to industry through Houdry services. These include Economic Consultation, Engineering, Research, and Technical Assistance—covering the entire range of catalytic processing.

STRATCO CONTACTORS

The Answer to Efficient Production of...



ALKYLATE

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DODECYLBENZENE

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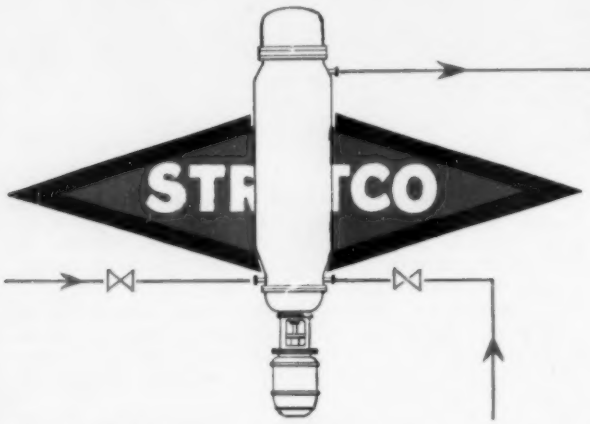

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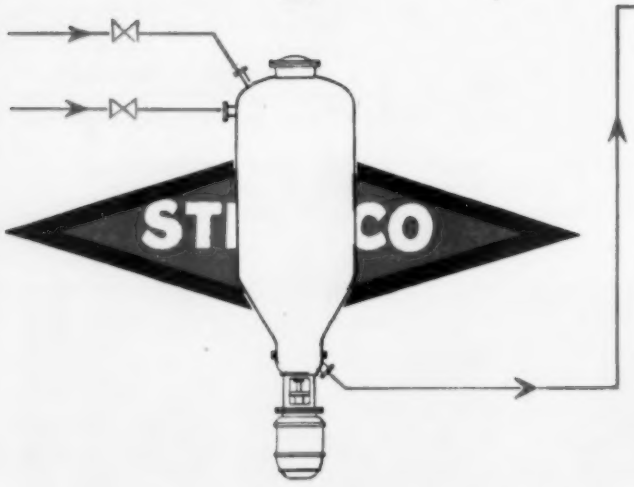

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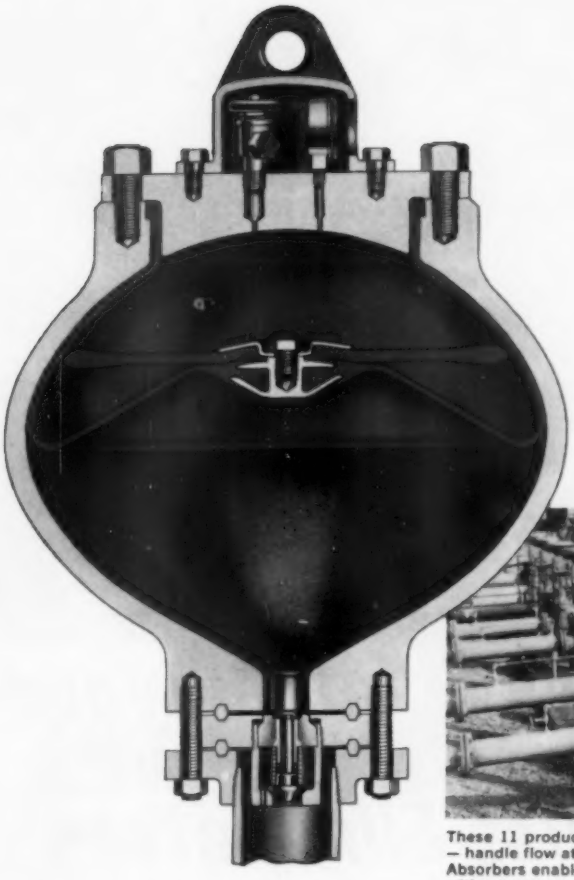

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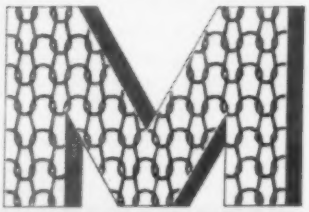

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Edmister joins Petro/Chem Engineer staff

A DISTINGUISHED NAME in the Hydrocarbon Process Industry joins the *Petro/Chem Engineer* masthead with this issue.

We are proud to announce the association of Wayne C. Edmister, Professor of Chemical Engineering at Oklahoma State University, in the capacity of associate editor and technical consultant.

Edmister, whose *Petro/Chem Engineer* series "Hydrocarbon Absorption and Fractionation Process Design Methods" has brought him industry-wide recognition, will update this material for publication in future issues of this magazine.

He will draw upon his extensive experience to plan and obtain exclusive technical articles of high interest to design engineering in HPI and will act in an editorial capacity in selecting and editing technical material proposed for publication that comes within his area of specialization.

Edmister, a registered professional engineer in Oklahoma, holds a BS in mechanical engineering from Oklahoma State, MS in mechanical engineering from Cornell University, and a professional degree in chemical engineering from Oklahoma State.

He joined the Oklahoma State faculty in 1958 and currently teaches in thermodynamics, distillation, and process design while engaged in research work on the thermodynamic properties of non-ideal hydrocarbon mixtures.

Edmister is presently serving as project director on four major thermodynamic research projects . . . the vapor-liquid "K" value project; project on vapor-liquid equilibrium ratios for heavy petroleum hydrocarbons for use in integral method for vaporization and distillation calculations; project on enthalpies of gas-liquid mixtures, and research on high pressure vapor-liquid equilibrium. The first three are sponsored, respectively, by the Natural Gasoline Association of America, Esso Research & Engineering Co., and the National Science Foundation.

He is also associated with the Phillips Petroleum Co. research and development division as a consultant on process design and technical data problems.

Prior to returning to Oklahoma State as a faculty member, Edmister served both in industry and as an educator. He has been a member of the staff at Carnegie Institute of Technology and an evening instructor at Illinois Institute of Technology, New York University, and the University of California.

Wayne C. Edmister, P. E.

In industry he engaged in technical data compilation and unit operation and design methods development for California Research Corporation, petroleum refinery project design for Foster Wheeler Corporation, and process design for Standard Oil Company (Indiana).

In 1960 Edmister received an international research grant from the Petroleum Research Fund of the American Chemical Society. On this grant he studied and did research in the Van der Waals Laboratory at the University of Amsterdam from May 1 through September 10, 1960.

Edmister was selected for the 1957 Richards Memorial Award from the American Society of Mechanical Engineers and was a Telluride Association Fellow at Cornell.

He is well known for his numerous publications and technical papers pertaining to the Hydrocarbon Process Industry.

Edmister is a member of the American Institute of Chemical Engineers, American Society of Mechanical Engineers, American Chemical Society, American Society for Engineering Education, Pi Tau Sigma, Phi Kappa Phi, Sigma Tau, and Sigma Xi.

Continued expansion seen in outlook

CHARLES E. WEBBER

THE YEAR 1960 witnessed an acceleration in natural gas processing operations after two years at a slackened pace along with the rest of the petroleum industry. This acceleration will continue in 1961. Several major projects to process gas as well as pipeline transportation networks for disposition of products will be launched this year.

The long term outlook for expansion in gas processing is good, even though the rate will be at a lesser pace than that to which the industry has become accustomed. Gas processing obviously must conform to the growth pattern of the natural gas industry.

The supply of this basic raw material has ceased to follow its normal trend over many years. Fig. 1 shows annual volumes of natural gas produced and that portion processed for liquid product recovery during the period 1935 through 1960. For 20 years the gross production followed a Gompertz curve, shown by the solid light line.

In 1954 the U. S. Supreme Court handed down the Phillips decision. The results soon became evident. The growth of natural gas production dropped off. The uncertainties and lack of incentive for exploration and production activities created by federal regulation of producers are taking thier toll. Only the most optimistic foresee a return to the former growth pattern.

Nothing in Washington is happening to reduce the confusion and concern of the gas producer. In fact, the announced intention to adhere to the area price stand-

CHARLES E. WEBBER, President of the Natural Gasoline Association of America and Director of Natural Gas Administration for Sun Oil Company, ranks as a top authority on the gas processing industry.

Webber, a registered professional engineer in Texas and Pennsylvania who received the NGAA's Hanlon Award in 1957, is particularly interested in new processes and application of new materials and concepts that can result in more economic investment and operating costs for gas processing facilities.

A Stillwater, Oklahoma, native, Webber holds BS and MS degrees in chemical engineering from Louisiana State University. He began his engineering career in 1934 in Humble Oil's petroleum engineering department service laboratory in Houston, transferring to East Texas two years later as a chemist for three Humble gasoline plants.

In 1937 he returned to Houston, where he aided in design and construction of several small gasoline plants — Tomball, Flour Bluff, Dickinson, and Heyser. He also aided in the experimental determination of vaporization equilibrium

for natural gas processing

ards recently set forth in a policy statement by FPC has created additional problems. This policy establishes two sets of ceiling prices — one for new sales and one for sales under older contracts. In certain areas the difference between these two ceiling prices is large.

Already gas processors whose residue gas is contracted for sale under old agreements (and subject to the lower ceilings) are having trouble tying in newly developed gas production because the owners of such production are holding back, hoping for better propositions from new plants or facilities where the residue gas goes to the more favorably priced markets. This is just one of the many problems of the gas processor as a result of regulation.

Going back to Fig. 1, the anticipated future annual production of gas is projected to 1970 and will be somewhere in the vicinity of 19 trillion cu ft. The portion processed and historically geared to production is likewise projected and will be some 13.5 trillion cu ft. For a considerable period of time, the overall average unit recovery of liquids from gas has been about 1.45 gal per Mcf. Applying this figure to the 1970 anticipated volume of gas processed results in an annual production of liquid product volume of 19.6 billion gal (1,280,000 bbl daily). This will be an ever more important part of the domestic petroleum energy supply.

Fig. 2 shows the production from plants by products for the period 1940 through 1960 with the total forecast to 1970. It is interesting to note that natural gasoline,

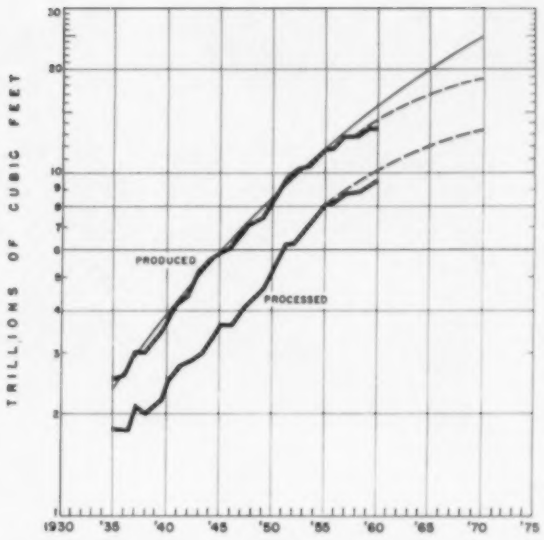

FIG. 1. Natural gas produced and processed in the United States.

formerly the principal product of the processing operation, reached a peak during the early 1950s and is declining, whereas the production of lighter hydrocarbons continues to enjoy phenomenal growth.

Natural gasoline — once a problem, later an important blending ingredient of motor gasoline, and now

---

constants for components of natural gas in absorption oil. This was mainly for the purpose of determining the feasible upper operating pressure limit for oil absorption operations in connection with design of the Katy cycling plant.

While working on design of the Katy plant, Webber in 1942 was called to Washington into what soon became the Petroleum Administration for War. It was his responsibility to handle priority applications for critical materials for natural gas processing plants as well as gas-condensate wells. He worked closely with industry to raise the level of natural gasoline, butanes, propane, condensate, and other products for military purposes.

When the war ended, Webber joined Sun Oil in Philadelphia as Assistant Manager of the Natural Gas Department, which was being formed to construct Sun's first natural gasoline plants (Delhi, Sun, and Jameson) and to develop gas markets throughout Sun's operating territory.

He was called back to Washington in 1951 during the Korean conflict to be Director of the Natural Gas Production and Processing Division of the Petroleum Administration for Defense and remained a consultant to the government for a period thereafter as a member of the Miiltary Petroleum Advisory Board.

In 1955 he became Technical Adviser to Sun's Vice President, Jno. G. Pew, and in early 1960 he was placed in charge of the company's newly formed Natural Gas Administration, established to handle Sun's regulatory problems with the Federal Power Commission.

Webber is a director and counsellor of the American Petroleum Institute and is active on six API committees. He also serves on committees of the Independent Petroleum Association of America, American Gas Association, National Petroleum Council and American Society for Testing Materials, and holds membership in the American Institute of Chemical Engineers, American Chemical Society, and the Society of Petroleum Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

He is author of a number of technical articles on gas processing.

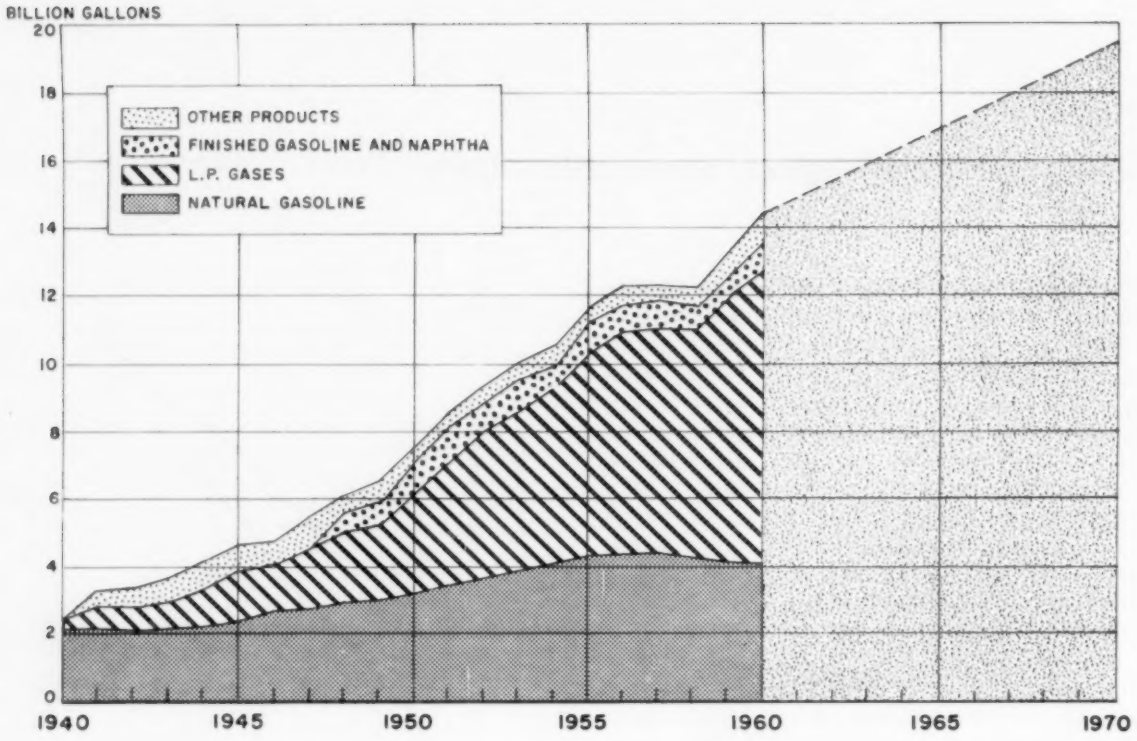

FIG. 2. Production of the U. S. natural gas processing industry, 1940-1960.

merely a refinery raw material with the name "gasoline" still tagged onto it — must seek new uses. Technological advances in the chemical industry are requiring more and different feedstocks from the petroleum industry.

A recent opportunity to utilize natural gasoline as a chemical feedstock failed because of a federal tax problem. This problem involves the application of the motor fuel excise tax to natural gasoline regardless of its actual disposition. Industry efforts to eliminate this obstacle by Congressional action are under way and a successful remedy is anticipated in 1961.

Also the natural gasoline plant operator has never been in the habit of entering into long term agreements for the sale of natural gasoline, as required by the chemical industry. Perhaps the continued hope of natural gasoline being considered solely as an important motor fuel ingredient is unrealistic. A second round of greater ethane extraction from existing gas streams in numerous older and larger plants is already under way. The economics of this second round are critical.

Part of the apparent decline in natural gasoline production is a statistical problem. Dozens of new solid desiccant adsorption units are being installed each year. These occur on gas streams produced in isolated locations even though a second processing operation on the residue gas occurs later along the gas pipeline. Frequently what otherwise might be termed natural gasoline produced in a gasoline plant is now recovered in one of these units and immediately mixed with crude or condensate, thereby losing its identity. Removal of liquefiable products starts simultaneously with the commencement of gas sales and can follow the expansion and development of the field merely by adding additional units.

In the larger installations, deeper and deeper refrigeration in conjunction with light absorption oil will continue to be the prime medium of liquid removal. Networks of raw product gathering with central fractionation and further processing gradually will cover the more concentrated area of gas processing operations. These pipeline networks of product gathering and disposition will play a material role in creating increased demand.

The year 1961 will see some expansion of helium operations. However, the general business climate coupled with the complicated facilities and the requisite governmental negotiations do not appear conducive to anything spectacular.

Increased consumption of natural gas by some 32,000,000 customers creates problems of peak demand. Distributing utilities and cross country pipelines are looking seriously at liquefied natural gas as a remedy. Large mined caverns in the concentrated coastal consuming areas hold promise as storage reservoirs for liquefied natural gas coming in by tanker. The investment requirements for facilities and tanker transportation are not, however, for the timid. ★ ★ ★

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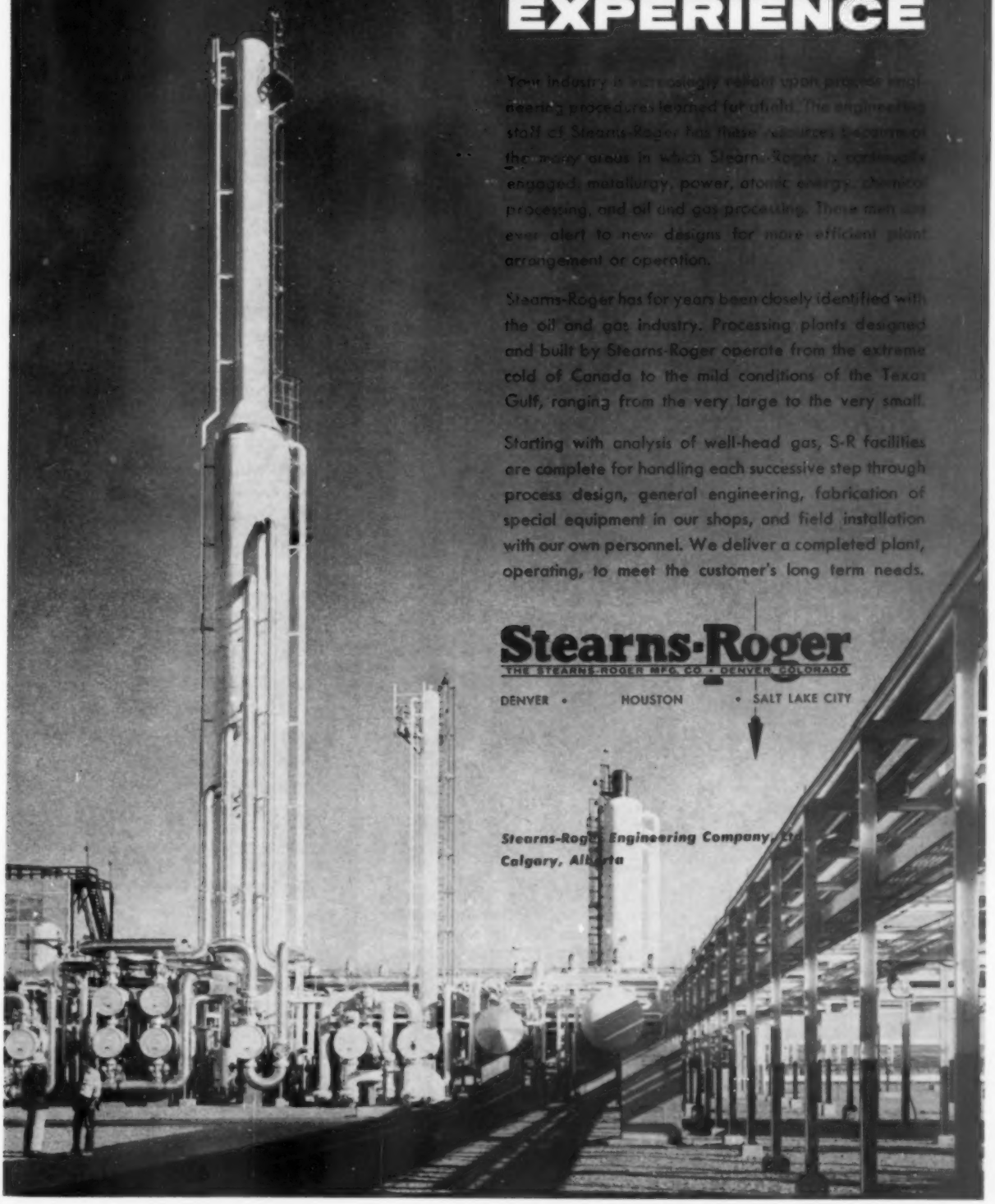

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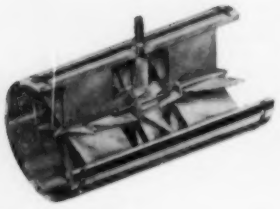

This in-line instrument measures liquid flow and transmits pulses for use in readout or flow-control equipment. Standard sizes of 1", 2", 4", 6", and 8" can be furnished with any end connection desired. Flow Meter requires *no lubrication.* Pre-calibrated turbines are interchangeable and operate within ±1% accuracy limits.

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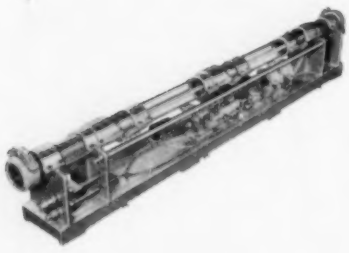
HALLIBURTON DENSOMETER



This instrument can be used to continuously record and/or control fluid densities without interrupting flow in the system. No interpolation or indirect measuring is involved — density is read directly and errors due to velocity, viscosity, pressure and product composition are precluded.

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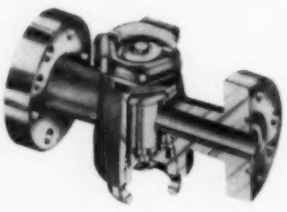
HALLIBURTON LO-TORQ GAS PLUG VALVE



This positive seal plug valve is equipped with teflon inserts for applications in gas containment from 1,000 to 15,000 psig working pressures. Exhaustive performance tests have proved the Lo-Torq will outlast comparable gate valves in holding pressure lines *bubble tight!* Full opening sizes range from 2" through 3" equipped with screwed or flanged end connections.

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The Underwood method has gained wide acceptance among process engineers. The common method of using the Underwood equations is incorrect on several points. Here is an article that discusses these points and offers a procedure for its proper use and applies it in a sample problem.

For multicomponent columns . . .

how to calculate minimum reflux

R. C. ERBAR R. S. JOYNER R. N. MADDOX
Oklahoma State University, Stillwater, Oklahoma

MOST DESIGN TECHNIQUES for multicomponent columns involve calculating the minimum reflux rate and the minimum number of trays. From these values, the actual reflux rate and actual number of trays are estimated. This estimate can be checked by plate-to-plate calculations. Procedures for plate calculations that do not require estimates of reflux and plates are available. When using one of these, however, a good estimate of these parameters is very helpful.

Methods for calculating the minimum number of trays are presented in the literature.[4,11] Variations between different techniques are not great. Calculating the minimum reflux rate is more difficult.

Many methods have been presented for calculating the minimum reflux ratio for multicomponent distillation separations. The method presented by Underwood,[9,10] has found widespread acceptance among chemical engineers. The two equations presented by Underwood are

$$\sum_{i=1}^{i=n} \frac{\alpha_i x_{f_i}}{\alpha_i - \phi} = 1 - q \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$\sum_{i=1}^{i=n} \frac{\alpha_i x_{d_i}}{\alpha_i - \phi} = R_m + 1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where

α = relative volatility, assumed constant
x = mole fraction
q = (heat required to vaporize feed) ÷ (heat required to vaporize feed if a saturated liquid)
ϕ = constant
R = reflux ratio = Lo/D
n = number of components
i = refers to any component
d = refers to distillate
f = refers to feed

The common procedure for using these equations is:

1. Use Fenske,[4] relation to calculate the distillate composition.
2. Use Equation 1 to solve for the value of ϕ between α's of the key components.
3. Use this value of ϕ in Equation 2 to determine R_m.

This procedure for calculating the minimum reflux is incorrect on several points. For a given combination of reflux

R. C. Erbar's present address: California Research Corporation, Richmond, California.

and plates, product composition is unique. No other reflux-plates combination will give exactly the same product composition.

Thermodynamic studies,[5,6] have shown that only two composition variables can be fixed. These can be one component and a product stream rate or two components. We should note here that specifying a mole fraction implicitly fixes the total quantity of the stream. The engineer cannot fix the reflux rate and number of plates and, in addition, specify an overhead recovery of 40 moles of product that is 95% B. He can, however, specify recovery of 38 moles of B and 40 moles of total overhead product, or 38 moles of B and 2 moles of C.

We can see from the above that correct use of Underwood's method will involve prediction of product composition. The procedure to be used is outlined below.

Underwood's equations can be rearranged to a more usable form if compositions are expressed as moles rather than mole fractions. This change is made by multiplying each equation by the appropriate quantity, F or D.

$$\sum_{i=1}^{i=n} \frac{\alpha_i f_i}{\alpha_i - \phi} = V_f \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$\sum_{i=1}^{i=n} \frac{\alpha_i d_i}{\alpha_i - \phi} = V_R \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where f = moles of component in feed

d = moles of component in distillate

V_f = moles of vapor in feed

V_R = moles of vapor leaving plates in the rectifying section (assumed constant)

In Equation 3 all values are known except ϕ. There are $n-1$ positive values of ϕ that will satisfy the equation, one between each adjacent pair of α's. Using these in Equation 4 it is possible to write $n-1$ independent forms of Equation 4.

$$\frac{\alpha_1 d_1}{\alpha_1 - \phi_1} + \frac{\alpha_2 d_2}{\alpha_2 - \phi_1} + \ldots\ldots\ldots + \frac{\alpha_n d_n}{\alpha_n - \phi_1} = V_R$$

$$\frac{\alpha_1 d_1}{\alpha_1 - \phi_2} + \frac{\alpha_2 d_2}{\alpha_2 - \phi_2} + \ldots\ldots\ldots + \frac{\alpha_n d_n}{\alpha_n - \phi_2} = V_R$$

$$\frac{\alpha_1 d_1}{\alpha_1 - \phi_{n-1}} + \frac{\alpha_2 d_2}{\alpha_2 - \phi_{n-1}} + \ldots\ldots\ldots + \frac{\alpha_n d_n}{\alpha_n - \phi_{n-1}} = V_R$$

These $n-1$ equations contain $n+1$ unknowns: $d_1, d_2, \ldots d_n, V_R$. If two of these are specified the $n-1$ remaining may be determined by solving the $n-1$ equations.

In presenting his equations, Underwood,[10] points out that for a non-distributed system one value of ϕ must be used. (Underwood defines a non-distributed system as one in which only the key components appear in both distillate and bottom product.) He also notes that one additional value of ϕ must be used for each distributed component with volatility intermediate to the keys.

By using all $(n-1)$ values of ϕ we have assumed a completely distributed system. *How can this assumption be checked?* Experience has shown that unrealistic values of d will be calculated for the non-distributed components. The term, **"unrealistic values,"** is used to describe conditions that cannot be met within the physical limitations of the system. For a component appearing only in the distillate, the d calculated by Equation 4 will be equal to or greater than the quantity of that component in the feed. For a component appearing only in the bottom, d will be equal to or less than zero. In either of these cases the calculated d is adjusted to its proper value, $d = f$, or $d = 0$. The correct value of minimum reflux must then be calculated by using the corrected d's in Equation 4 with $\alpha_{lk} > \phi > \alpha_{hk}$.

Mention should be made here that minimum reflux is the only condition of column operation that can have non-distributed components. Bonner, [1] Lyster, et al,[7] Winn[11] and J. Erbar-Maddox[3] have demonstrated that at total and/or finite reflux there is a finite and calculable quantity of every feed component in each product stream. Brown and Souders,[2] derived equations for the "pinch" or constant composition zone which show that non-distributed components can occur at minimum reflux. The Brown and Souders rectifying pinch zone equation is

$$v_{R_i} = \frac{d_i}{1 - \left(\frac{L}{K_i V}\right)_R} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where v_R = moles of component in vapor stream in rectifying pinch

d = moles of component in distillate

$\left(\frac{L}{K_i V}\right)_R$ = absorption factor in rectifying pinch

Studying Equation 5 we see that a component with a small K_i (large $\frac{L}{K_i V}$ with $\frac{L}{V}$ the same for all components) would have a negative v_R if d were positive. Since negative compositions are impossible, d must go to zero for these components. A similar equation and line of reasoning applies to the stripping pinch zone.

Proper use of Underwood's equations, based on the above discussion, involves:

1. Solve for $n-1$ values of ϕ to satisfy Equation 3. ϕ values fall between adjacent values of α.
2. Fix two values of d. (These will normally be fixed by the conditions and specifications of the problem.)
3. Write $n-1$ equations of the form of (4), one for each value of ϕ.
4. Solve for the $n-2$ remaining distillate quantities and the minimum vapor rate in the rectifying section, V_R.
5. Correct any impossible values of d.
6. If any corrections were made in step 5, recalculate V_R using $\alpha_{lk} > \phi > \alpha_{hk}$.

This procedure will be clarified by the illustrative problem below:

Problem 1.

The feed to a distillation column has the composition given below. We propose to produce an overhead product at

least 95% C_2. The tower is to operate at 300 psia with a partial condenser and feed at its bubblepoint.

Comp	Mole %
C_2 (ethane)	40.70
C_3 (propane)	45.09
iC_4 (i-butane)	5.30
nC_4 (n-butane)	6.20
iC_5 (pentane)	2.71
	100.00

Solution

Step 1.

In order to write Equation 3 we need the average α for the tower. For a first assumption, assume the feed enters at the average tower temperature.

Feed bubblepoint, assume 80 deg

Comp	Mole %	$K_{80°}^{300°\ 12}$	y = KX	α_{avg}
C_2	40.70	1.64	66.9	2.72
C_3	45.09	.602	27.2	1.00
iC_4	5.30	.330	1.8	.549
nC_4	6.20	.260	1.6	.431
iC_5	2.71	.123	.3	.204
			97.8	

$\Sigma Y = 97.8 \cong 100$ so a temperature of 80 deg will be assumed for the average tower temperature.

Using these values of α in Equation 3

$$\frac{2.72 \times 40.70}{2.72 - \phi} + \frac{1.00 \times 45.09}{1.00 - \phi} + \frac{.549 \times 5.30}{.549 - \phi} + \frac{.431 \times 6.20}{.431 - \phi} + \frac{.204 \times 2.71}{.204 - \phi} = 0$$

from this $\phi_1 = 1.52$
$\phi_2 = 0.573$
$\phi_3 = 0.451$
$\phi_4 = 0.211$

Step 2.

If we assume no components heavier than propane will appear (in appreciable quantity) in the overhead we can use $\left(\frac{b}{d}\right)_{lk} = 30$ and $\left(\frac{d}{b}\right)_{hk} = 30$ and produce

96 + % C_2 as overhead. Based on these assumptions,

$$d_{C_2} = 39.39 \text{ moles}$$

$$d_{C_3} = 1.455 \text{ moles}$$

Step 3. Writing Equation 4 for all values of ϕ_1.

For ϕ_1.

$$\frac{2.72 \times 39.39}{2.72 - 1.52} + \frac{1.00 \times 1.455}{1.00 - 1.52} + \frac{.549 \times \text{diC4}}{.549 - 1.52} + \frac{.431 \times \text{dnC4}}{.431 - 1.52} + \frac{.204 \times \text{diC5}}{.204 - 1.52} = V_R$$

reducing this

$$89.2 - 2.8 - .565d_{iC_4} - .396d_{nC_4} - .155d_{iC_5} = V_R$$

rearranging

$$.565d_{iC_4} + .396d_{nC_4} + .155d_{iC_5} + V_R = 86.4$$

Following a similar procedure for ϕ_2, ϕ_3, and ϕ_4,

$$\phi_2 = 0.573;$$
$$22.8d_{iC_4} + 3.04d_{nC_4} + .544d_{iC_5} + V_R = 53.31$$

$$\phi_3 = 0.451;$$
$$-5.6d_{iC_4} + 21.55d_{nC_4} + .826d_{iC_5} + V_R = 49.75$$

$$\phi_4 = 0.211;$$
$$-1.67_{iC_4} - 1.96d_{nC_4} + 29.1d_{iC_5} + V_R = 44.45$$

Step 4. Solve the equations.

A set of equations such as this can be solved by many methods. Perhaps the easiest and fastest is the use of matrix techniques. Matrices are readily adaptable to computer solution but are also suitable for slide-rule or desk calculator computation. Because many engineers are not familiar with the calculations involved, they will be presented in detail. Cholesky's[8] scheme of matrix solution sometimes called Crout's method, will be used.

For convenience, the four equations will be treated as if written in the form:

$$V_R + 0.565d_{iC_4} + 0.396d_{nC_4} + 0.155d_{iC_5} = 86.4$$

From the four equations we have the coefficient matrix

$$\begin{pmatrix} a_{1,1}a_{1,2}a_{1,3}a_{1,4}a_{1,5} \\ a_{2,1}a_{2,2}a_{2,3}a_{2,4}a_{2,5} \\ a_{3,1}a_{3,2}a_{3,3}a_{3,4}a_{3,5} \\ a_{4,1}a_{4,2}a_{4,3}a_{4,4}a_{4,5} \end{pmatrix} = \begin{pmatrix} 1.0 & 0.565 & 0.396 & 0.155 & 86.4 \\ 1.0 & 22.8 & 3.04 & 0.544 & 53.31 \\ 1.0 & -5.6 & 21.55 & 0.826 & 49.75 \\ 1.0 & -1.67 & -1.96 & 29.1 & 44.45 \end{pmatrix}$$

$$V_R \; d_{iC_4} \; d_{nC_4} \; d_{iC_5}$$

(These denote the column of matrix associated with each unknown.)

We will write an auxiliary matrix of the form

$$\begin{pmatrix} t_{1,1}t_{1,2}t_{1,3}t_{1,4}t_{1,5} \\ t_{2,1}t_{2,2}t_{2,3}t_{2,4}t_{2,5} \\ t_{3,1}t_{3,2}t_{3,3}t_{3,4}t_{3,5} \\ t_{4,1}t_{4,2}t_{4,3}t_{4,4}t_{4,5} \end{pmatrix}$$

The coefficients in the auxiliary matrix are generated as follows:

A. Write down the first column unchanged

$$t_{1,1} = a_{1,1};\ t_{2,1} = a_{2,1} \text{ ----- } t_{i,1} = a_{i,1}$$

B. Calculate the remainder of the first row by

$$t_{1,2} = a_{1,2} \div a_{1,1};\ t_{1,3} = a_{1,3} \div a_{1,1} \text{ ----- } t_{1,j} = a_{1,j} \div a_{1,1} (j > 1)$$

i.e. $t_{1,2} = 0.565 \div 1.0 = 0.565$

C. Calculate the remainder of the second column by

$$t_{2,2} = a_{2,2} - (a_{2,1})(t_{1,2});\ t_{3,2} = a_{3,2} - (a_{3,1})(t_{1,2});$$
$$t_{i,2} = a_{i,2} - (a_{i,1})(t_{1,2})(i > 1)$$

i.e. $t_{2,2} = 22.8 - (1.0)\ (0.565) = 22.235$

D. Calculate the remainder of the second row by

$$t_{2,3} = a_{2,3} - (a_{2,1})(t_{1,3}) \div t_{2,2};$$

$$t_{2,4} = a_{2,4} - (a_{2,1})(t_{1,4}) \div t_{2,2}$$

$$t_{2,j} = a_{2,j} - (a_{2,1})(t_{1,j}) \div t_{2,2}\ (j > 2)$$

i.e. $t_{2,3} = 3.04 - (1.0)(0.396) \div 22.235 = 0.119$

E. Calculate the remainder of the third column by

$$t_{2,3} = a_{3,3} - (a_{3,1})\ (t_{1,3}) - (t_{2,3})\ (t_{3,2});\ t_{i,3} = a_{i,3} - (a_{i,1})(t_{1,3}) - (t_{2,3})(t_{i,2})\ (i > 2)$$

i.e. $t_{3,3} = 21.55 - (1.0)(0.396) - (0.119)(-6.16) = 21.55 - 0.396 + .518 = 21.672$

F. Calculate the remainder of the third row by

$$t_{3,4} = [a_{3,4} - (a_{3,1})\ (t_{1,4}) - (t_{3,2})\ (t_{2,4})] \div t_{3,3}$$

$$t_{3,j} = [a_{3,j} - (a_{3,1})\ (t_{1,j}) - (t_{3,2})\ (t_{2,j})] \div t_{3,3}\ (j>3)$$

i.e. $t_{3,4} = [0.826 - (1.0)(0.155) - (-6.16)(0.0175)] \div 21.67 = 0.0359$

G. Calculate the remainder of the fourth column by

$$t_{4,4} = a_{4,4} - (a_{4,1})\ (t_{1,4}) - (t_{2,4})(t_{4,2}) - (t_{3,4})(t_{4,3})$$

i.e. $t_{4,4} = 29.1 - (1.0)(0.155) - (0.0175)(-2.23) - (0.0359)(-2.09) = 29.1 - 0.155 + 0.0391 + 0.075 = 29.06$

H. Calculate the remainder of the fourth row by

$$t_{4,5} = [a_{4,5} - (a_{4,1})\ (t_{1,5}) - (t_{4,2})\ (t_{2,5}) - (t_{4,3})\ (t_{3,5})] \div t_{4,4}$$

$$= [44.45 - (1.0)(86.4) - (-2.23)(-1.49) - (-2.09)\ (-2.11)\ ] \div 29.06 = [44.45 - 86.4 - 3.32 - 4.42] \div 29.06 = -1.71$$

The completed auxiliary matrix is:

$$\begin{pmatrix} t_{1,1}t_{1,2}t_{1,3}t_{1,4}t_{1,5} \\ t_{2,1}t_{2,2}t_{2,3}t_{2,4}t_{2,5} \\ t_{3,1}t_{3,2}t_{3,3}t_{3,4}t_{3,5} \\ t_{4,1}t_{4,2}t_{4,3}t_{4,4}t_{4,5} \end{pmatrix} = \begin{pmatrix} 1.0 & 0.565 & 0.396 & 0.155 & 86.4 \\ 1.0 & 22.24 & 0.119 & 0.0175 & -1.49 \\ 1.0 & -6.16 & 21.67 & 0.0359 & -2.11 \\ 1.0 & -2.23 & -2.09 & 29.06 & -1.71 \end{pmatrix}$$

The auxiliary matrix may now be solved for the original unknowns

$$d_{iC_5} = t_{4,5} = 1.71$$

$$d_{nC_4} = t_{3,5} - t_{3,4}(d_{iC_5}) = -2.11 - (0.0359)(-1.71) = -2.05$$

$$d_{iC_4} = t_{2,5} - t_{2,3}(d_{nC_4}) - t_{2,4}(d_{iC_5}) = -1.49 - (0.119)(-2.05) - (0.0175)(-1.71) = -1.49 + 0.244 + .03 = -1.22$$

$$V_R = t_{1,5} - t_{1,2}(d_{iC_4}) - t_{1,4}(d_{nC_4}) - t_{1,4}(d_{iC_5}) = 86.4 - (0.565)(-1.22) - (0.396)(-2.05) - (0.155)(-1.71) = 86.4 + 0.69 + 0.81 + 0.26 = 88.16$$

Step 5. Check calculated d's for physical consistency. Obviously, the correct values should be

$$d_{iC_4} = d_{nC_4} = d_{iC_5} = 0$$

Step 6. Recalculate the value of V_r using $\alpha_{lk} > \phi > \alpha_{hk}$

$$89.2 - 2.8 - 0.565\ d_{iC_4} - 0.396\ d_{nC_4} - 0.155\ d_{iC_5} = V_r$$

$V_r = 86.4$ moles
$D = 40.84$ moles
$Lo = 45.56$ moles
$Lo/D = 1.115$

We must now check the assumption of the feed entering at the average tower temperature.

Overhead dew point = 22.4 deg
Bottoms bubblepoint = 151.3 deg
Average tower temperature = 86.8 deg
Feed bubblepoint = 80 deg

An error of this magnitude in the average temperature will not cause serious error in the minimum reflux. Solving the problem with an assumed average tower temperature of 86.8 deg gave the following results

Comp	α avg	ϕ	d	b
C_2	2.67		39.39	1.31
		1.513		
C_3	1.0		1.45	43.64
		.576		
iC_4	.555			5.30
		.455		
nC_4	.438			6.20
		.214		
iC_5	.210			2.71
			40.84	

$V_r = 88.08$
$D = 40.84$
$Lo = 47.24$
$Lo/D = 1.16$

Overhead dewpoint = 22.4
Bottoms bubblepoint = 151.3
Average tower temperature = 86.8 deg

References

1. Bonner, J. S., "Solution of Multicomponent Distillation Problems on a Stored Program Computer," presented at Am. Pet. Inst. meeting, Montreal Canada (1956).
2. Brown, G. G., and Souders, Matt, Jr., *Trans.* AIChE 30, 438 (1934).
3. Erbar, J., and Maddox, R. N., *Petro/Chem Engineer*, 31, No. 10, C-35 (1959).
4. Fenske, M. R., *Ind. Eng. Chem* 24, 482 (1937).
5. Gilliland, E. R., and Reed, C. E., *Ind. Eng. Chem.* 34, 557 (1942).
6. Kwauk, Mooson, AIChE Jour. 2, 240 (1952).
7. Lyster, W. N., et al, *Pet. Ref.* 38, 7, 221 (1959).
8. Salvadori, M. G., and Baron, M. L., *Numerical Methods in Engineering*, Prentice Hall, 1959.
9. Underwood, A. J. V., *Trans.* Inst. Chem. Engr. (London) 10, 119 (1932).
10. Underwood, A. J. V., C. E. P. 44, 8, 603 (1948).
11. Winn, F. W., *Pet. Ref.* 37, 5, 216 (1958).
12. ....., Natural Gasoline Association of America "K" Values.

How to save horsepower on . . .

propane refrigeration system design

K. D. ROBIRDS • J. C. MARTIN III

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THERE ARE PRONOUNCED TRENDS in today's gasoline plants toward lower absorption oil circulation rates and toward the processing of gas streams formerly considered too lean for economic payout. Both of these changes have caused refrigeration to consume an ever increasing portion of the capital dollars spent on new plants. As a result, it behooves all persons involved in gasoline plant design to become thoroughly familiar with the many aspects of process refrigeration.

For various reasons beyond the scope of this article, the large majority of gasoline plant process refrigeration is still supplied by reciprocating type propane sytems. These are usually considered to be rather stereotyped in design, but there are a few important choices that vary with the individual case. Depending on the temperature level involved and the refrigeration load, the use of a refrigerant vapor-liquid heat exchanger or an interstage liquid flash tank may prove advantageous.

The percentage change in system horsepower requirements that will result from the use of either of these two items will vary sharply with the temperature level required, but will be independent of over-all refrigeration load.

Once these relative horsepower figures have been established for the different mechanical systems throughout the normal range of evaporator temperatures, then the actual size (load) of any given system can be used to quickly determine the relative economics for the case in question.

In order to provide sufficient data for quick evaluation of propane systems, horsepower requirements for a wide variety of cases were calculated, and the results plotted as shown in the various curves that form the basis for this article.

The systems investigated all followed the basic outline of the flow diagram (Fig. 1), and the variation from system to system consisted of including or excluding the refrigerant heat exchanger and/or the interstage flash tank.

Evaporator temperatures from + 30 F to − 44 F (the saturation temperature of propane at 14.7 psia) were considered, and the horsepower requirements per ton of refrigeration for a bare system (no refrigerant heat exchanger or flash tank) are plotted against temperature in Fig. 2.

The percent reduction in horsepower to be expected from the use of interstage flashing at various temperatures is shown in Fig. 3. The horsepower savings are substantial at the lower temperature levels (− 10 F to − 44 F), but the amount of the saving diminishes with increasing temperatures and even becomes negative at temperatures above + 10 F. This is a result of comparing a two-stage system (required for interstage flashing), in which compressor and valve inefficiencies are doubled, to a single stage system.

With propane, single-stage compression ratios above five-to-one will usually result in such low volumetric efficiencies that unduly large cylinders will be required, and the pin and rod loads will become prohibitive. Therefore, a compression ratio of five-to-one is generally the break point between single and double staging. Discharge pressures will vary with the cooling water temperatures available, but 180 psig represents a good average.

Translating this back to suction pressures and saturation temperatures results in an evaporator temperature of ap-

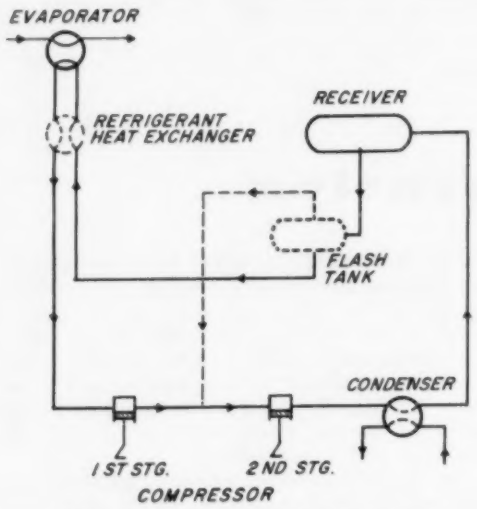

FIG. 1. Typical propane refrigeration system.

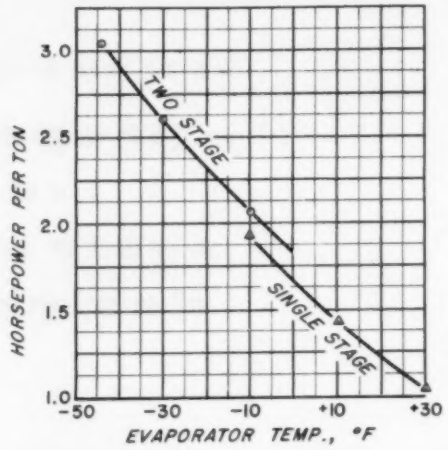

FIG. 2. Refrigeration horsepower for bare system. Operating conditions: reciprocating compressor, propane refrigerant; discharge pressure at 195 psia; and receiver pressure at 190 psia.

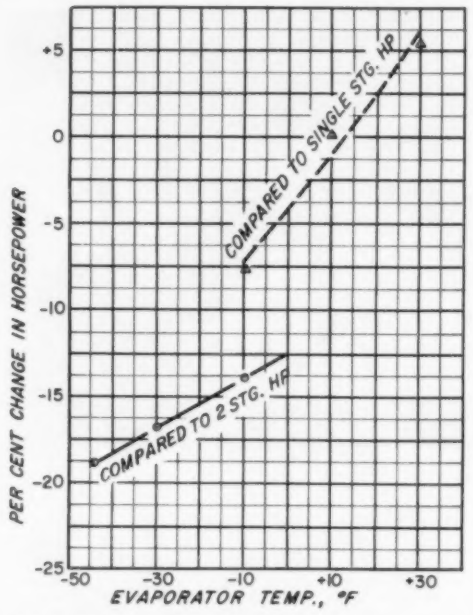

FIG. 3. Effect of interstage flashing on refrigeration horsepower (reciprocating compressor, propane refrigerant).

proximately 0 F being the lowest practically attainable with single-stage compression. Above this temperature, interstage flashing offers no advantage since it would require a two-stage system where a single stage would ordinarily suffice. At evaporator temperatures below 0 F, interstage flashing is definitely advantageous, but the relative merits of this system versus one utilizing a refrigerant heat exchanger must be determined.

The horsepower savings resulting from refrigerant vapor-liquid heat exchangers, with two different vapor-side pressure drops, are plotted in Fig. 4. The curve representing the heat exchanger with 3 psi pressure drop reflects a maximum horsepower reduction at −25 F, with diminishing savings below this point. The upward trend of the curve at the lower temperatures is a result of the increasing significance of the 3 psi pressure drop on compression ratios at the lower suction pressures. The lower curve represents a heat exchanger with zero psi pressure drop on the vapor side and shows steadily increasing horsepower savings with decreasing temperatures. The obvious conclusion reached from a comparison of these two curves is that vapor pressure drops must be kept close to zero psi if material horsepower savings are to be realized.

Assuming that pressure drop is held down to a negligible figure, the savings at the + 10 F level are worth considering in large tonnage systems, and the saving increases steadily as the temperature level decreases. Refrigerant heat exchangers are sometimes used to avoid the lubrication problems that would be experienced in extreme low temperature compression, but this is a minor consideration in propane systems. Another function of the refrigerant heat exchanger is to vaporize any entrained liquid in the suction vapors; but, if it is used for this purpose, consideration must be given to the pressure drop involved.

Excluding these other considerations, and considering only horsepower savings, a choice is available between the use of a refrigerant heat exchanger or the use of interstage flashing at temperatures below 0 F. This choice will be an economic one, depending primarily on the over-all capacity of the refrigeration system in question. Interstage flashing offers a much greater percent reduction in horsepower, but possibly at higher capital cost than a heat exchanger. In larger systems, the incremental horsepower savings will be large enough to justify the additional capital cost for the flash tank.

One other scheme that was considered was the use of both the heat exchanger and the flash tank. The potential savings for this system are plotted in Fig. 5, and they are roughly equivalent to the savings for the flash tank by itself.

This comparison of various propane refrigeration cycles can be summarized in three basic conclusions:

1. Significant over-all savings can be realized by the use of interstage flashing in propane systems that, due to a high over-all compression ratio, require two stage compression.

2. A refrigerant vapor-liquid heat exchanger, which is generally less expensive than a flash tank with controls, can offer attractive savings when evaporator temperatures are below + 10 F, if vapor side pressure drops are held close to zero psi.
3. Use of a refrigerant heat exchanger in conjunction with interstage flashing is undesirable from the standpoint of horsepower saving and economy of capital cost.

A brief discussion of the methods of calculation used will help the reader evaluate and utilize the data presented. The refrigerant was assumed to be pure propane, and liquid and vapor heat contents, as well as saturation temperatures and pressures, were obtained from an enlarged copy of the "Pressure-Enthalpy Diagram for Propane" in the NGSMA Engineering Data Book.

Horsepower requirements were taken from the "Basic Brake Horsepower Curves" in the NGSMA Engineering Data Book. The molal heat capacities of propane at temperatures from 0 F to + 300 F were used to calculate "n" values at the various temperatures which were then plotted (Fig. 6) for quick reference. The "n" value for each stage of compression was obtained using the average of suction and discharge temperatures. This variation of "n" value with temperature is not normally considered in calculations made by design engineers or compressor manufacturers; but, for establishing the relative merits of various refrigeration systems, it should be used.

Discharge temperatures were taken as isentropic (read from the NGSMA "Pressure-Enthalpy Diagram") plus 10 F per stage. Final discharge pressures were uniformly taken as 195 psia. A 5-lb pressure drop in the condenser would give a condensing temperature of 100 F, which can be achieved with reasonable water rates and condenser surfaces using water temperatures of 85 F in and 95 F out.

All pressure drops other than the drops through the condenser and refrigerant heat exchanger were assumed to be negligible, so as to give accurate comparison between the various systems. Temperature loss or gain due to ambient heat transfer was also assumed to be nil. All refrigerant heat exchangers were based on a 15 F temperature approach of warm vapors to warm liquid.

The deviation from ideal conditions (supercompressibility) was determined by dividing the actual specific volume read from the NGSMA "Pressure-Enthalpy Diagram" by the theoretical volume. The deviation was calculated at suction and discharge conditions for each stage of compression, and the numerical average of the two deviations was used in determining the horsepower for the stage.

These assumptions and calculation methods, when used together, have been found to give final horsepower figures that agree within 3% with those quoted by most compressor manufacturers. ★ ★ ★

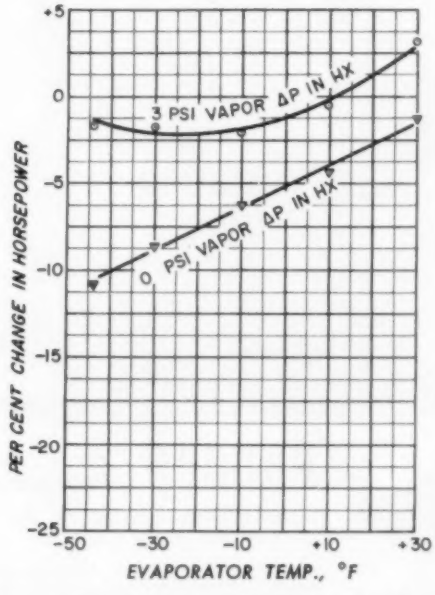

FIG. 4. Effect of refrigerant heat exchanger on horsepower requirements (reciprocating compressor, propane refrigerant).

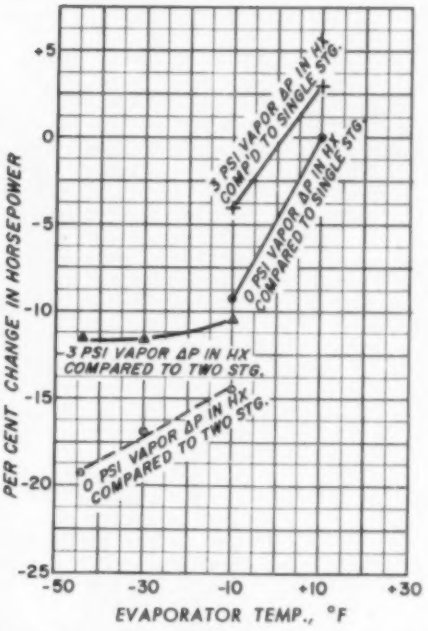

FIG. 5. Effect of interstage flashing and refrigerant heat exchanger on refrigeration horsepower (reciprocating compressor, propane refrigerant).

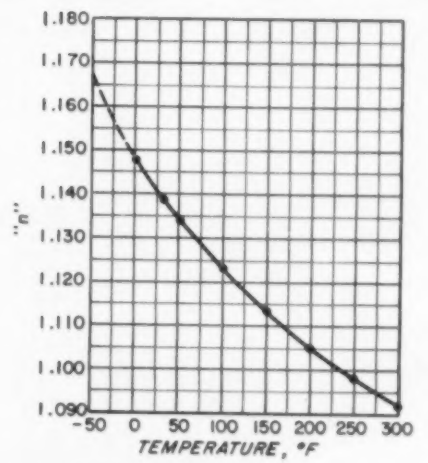

FIG. 6. Propane compression exponent.

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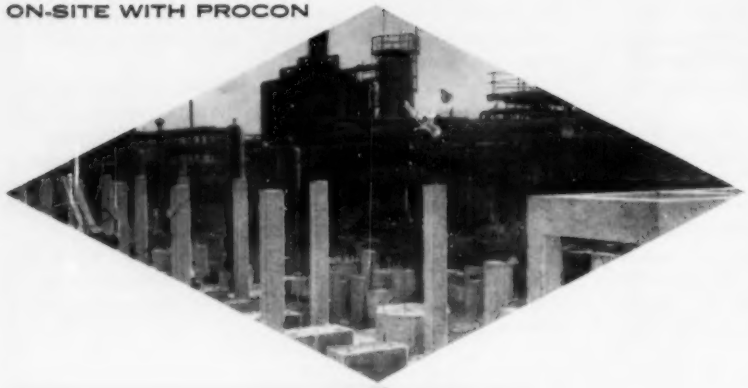

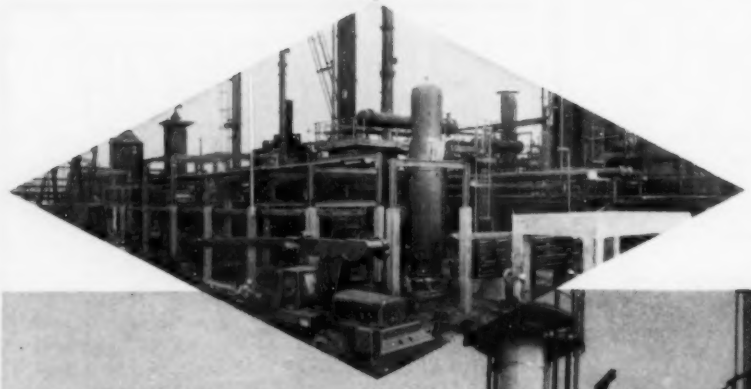

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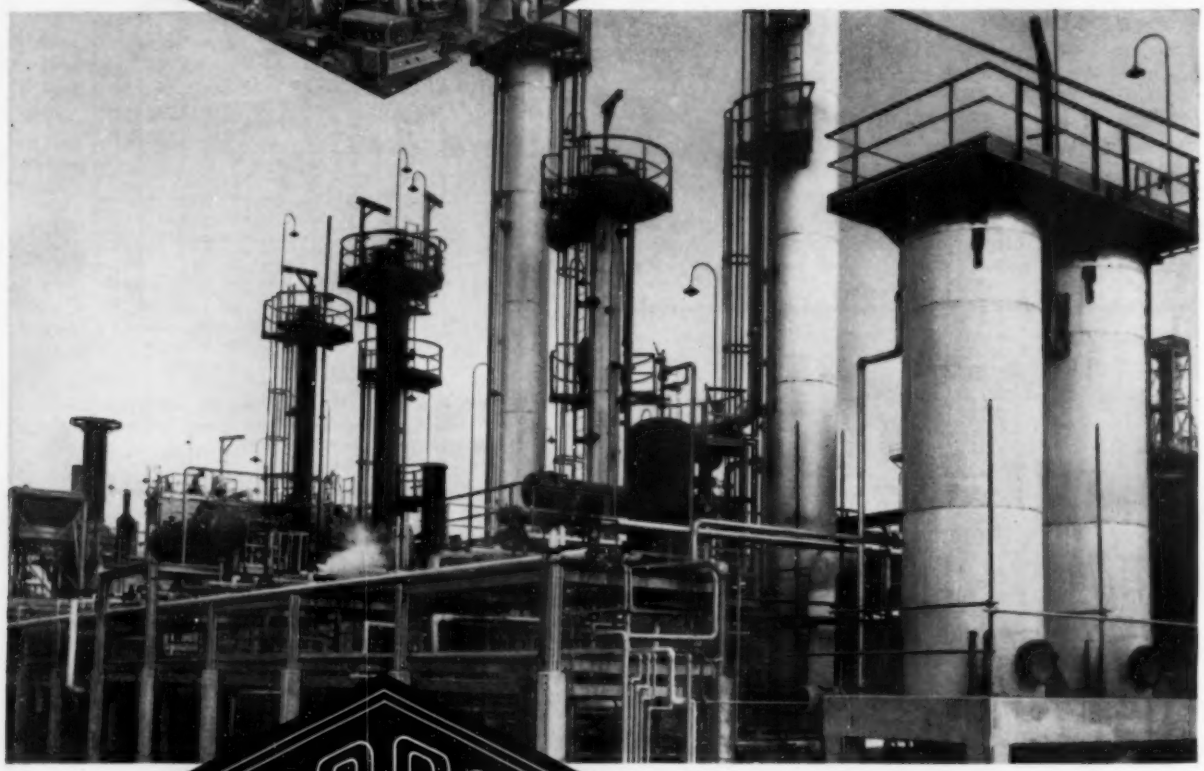

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Barium Fluoride
Bismuth Fluoride
Boron Trifluoride (Gas)
Boron Trifluoride Complexes
Cadmium Fluoborate
Chromium Fluoride
Copper Fluoborate
Fluoboric Acid
Fluorinating Agents
Frosting Mixtures
Hydrofluoric Acid Anhydrous
Hydrofluoric Acid Aqueous
Hydrofluosilicic Acid
Laboratory Fluorine Cells
Lead Fluoborate
Lithium Fluoride
Metallic Fluoborates
Nickel Fluoborate
Potassium Bifluoride
Potassium Chromium Fluoride
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Potassium Fluoride
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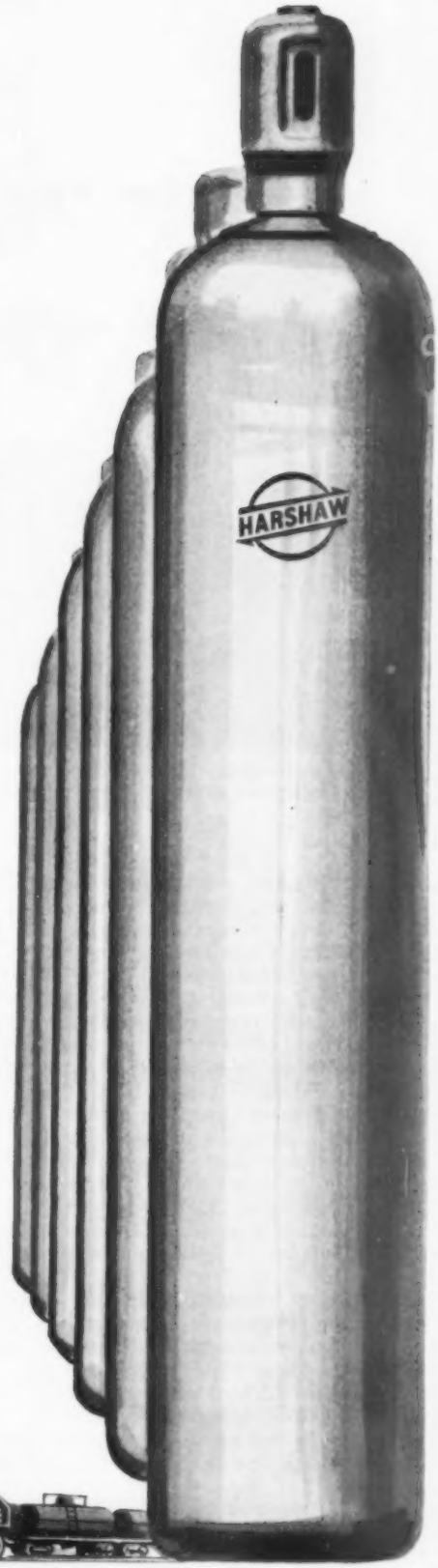

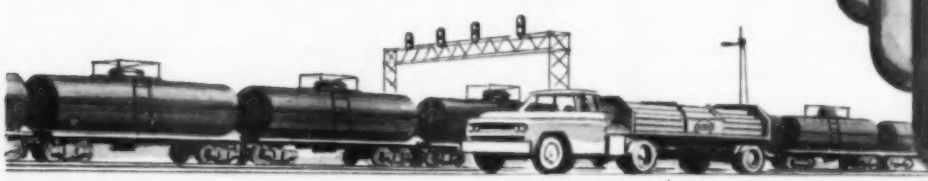

How to turbocharge gas engines

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ONLY 15 YEARS AGO, mention of rotating machinery speeds in multiples of 10,000 per minute was apt to cause visions of shrapnelling rotor fragments accompanied by the screech of failed high-speed bearings to rise in the minds of many practical engineers.

Since then, with the jet engine not only having assumed the role of most important prime mover in the commercial passenger transportation field, but also having proven itself more reliable and economic than its piston-type predecessor, these fears have abated. In the form of gas turbines for primary power generation or for driving equally fast centrifugal compression machinery, in the form of latest 3000-hp steam turbine designs running at 30,000 rpm, or in the form of large tonnage, centrifugal refrigerant compressors, running at 25,000 rpm, high-speed turbomachinery has thoroughly proven its inherent capability to match and even surpass the reliability standards of reciprocating-type machinery.

The era of turbocharged internal combustion engines may well in future retrospective be looked upon as an era of transition between that of the reciprocating engine and the turbomachine. Piston engine and turbomachine can, however, look forward confidently toward many years of profitable union before the all-turbomachine type of prime mover will have reached a development level from which the final attack into the field of the piston engine can be launched.

Retrofit turbocharging, i.e., the installation of turbochargers on engines in the field represents a quite unique technological method. A turbocharger functionally represents a vital, primary part of the engine's organism comparable to that providing oxygen in living organisms. The integration of a component as delicately affecting the basic life functions of any internal combustion engine into such an engine, therefore, would seem to call for the most careful and circumspective technique.

Here are some guide lines and experiences from successful turbocharger retrofit installations on gas engines within the last years.

Some Basic Considerations

The essential function of super- or turbocharging is to push more air, weight-wise, into the cylinders of an engine than the engine would be able to inhale by the vacuum created during the downstroke of the pistons. With more air in the cylinders, more fuel can be burned and, therefore, more power obtained from one cylinder charge. Since, generally speaking, combustion efficiency is improved if the combustion air has a higher density as a result of turbocharging, more power will be obtained per quantity of fuel burned or specific fuel consumption will be reduced.

Note that the density increase of the charge air affects the engine in two ways:

- An increase of engine air weight flow results in more power if a proportionally greater amount of fuel is injected.
- Increase of combustion air density results in better "thermal" efficiency or reduced specific fuel consumption.

With air density being

$$d = 1.324 \frac{P_1}{T_1} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Where:

d = density, lb/ cu ft
p = pressure, inches of mercury absolute
T = temperature, Rankin

it is obvious that both pressure (p_1) *and* temperature (T_1) in the engine inlet manifold are important delivery parameters of a turbo-charging system.

In most installations, non-supercharged 4-stroke engines operate with higher pressures in the exhaust collector than in the engine inlet manifold. This is due to pressure losses in the air filter and air intake duct as well as due to back pressure caused by mufflers and exhaust pipes.

In 4-stroke engines with small valve overlap a constant amount of charge air is displaced per cycle; therefore, the engine controls the volume flow of air at its inlet ports or at the discharge of the turbocharger compressor. An increase of charge-air flow, on a weight basis, can therefore be obtained by increasing the density of the charge air at this point. The ratio of inlet manifold and exhaust collector pressures could still be the same as in case of non-turbocharged operation.

With increasing valve overlap the engine, with respect to through flow, assumes characteristics more similar to

at a profit

an orifice. Therefore, more air could be pushed through the engine if the pressure in the exhaust manifold, in turbocharged operation, would be kept below the pressure in the intake manifold.

How large this "scavenge pressure differential" will be in turbo-charging depends on the ratio of exhaust collector to compressor inlet temperature (higher exhaust temperature means more energy to drive the turbine; lower compressor inlet temperature results in greater pressure rise for a given work input) and on the over-all efficiency of the turbocharger (turbocharger design quality influences degree of utilization of exhaust energy). Fig. 1a shows the basic relationship between adiabatic compression and expansion work, pressure ratio, and initial process temperature. Fig. 1b shows the derivation of a turbocharging "quality" factor τ and compressor and turbine pressure ratios as a function of τ. From this graph the difference between engine inlet manifold and exhaust manifold pressures can quickly be determined if compressor and turbine efficiency, or the product thereof as "turbocharger" efficiency, are known and also the temperatures at the compressor and turbine inlet (in most cases equalling ambient and exhaust manifold temperatures).

For a 4-stroke engine, the air volume flow at the inlet ports can be figured from

$$F = 4.8 \times 10^{-6} \times D \times S \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Where:

F = flow, cu ft/sec
D = displacement, cu in.
S = speed, revolutions per min

(The numerical factor in this expression is based on a volumetric efficiency of 100%. For other volumetric efficiencies modify this factor in direct proportion.)

To determine the weight flow per minute from the engine volume flow, multiply with inlet manifold air density. For density of air use Equation 1. This equation shows that to obtain a density increase of, say, 50%, the pressure increase must be higher than 50% since, by temperature increase during compression, T_1 increases so tending to reduce "d."

With no cooling of charge air between turbocharger compressor and engine, T is a function of compressor efficiency for a given pressure ratio. For example, to obtain a 50% density increase with a compressor of 80% efficiency, the pressure ratio would have to be 1.86.

The density equation shows further what intercooling would do. With 80% compressor efficiency, again for a 50% density increase, the compressor discharge temperature, for 90F inlet temperature, would be 224F. Assuming 29.92 in. mercury absolute compressor inlet pressure, compressor discharge pressure would be approx. 56 in. mercury absolute and charge-air density according to equation 1 .108 lb per cu ft.

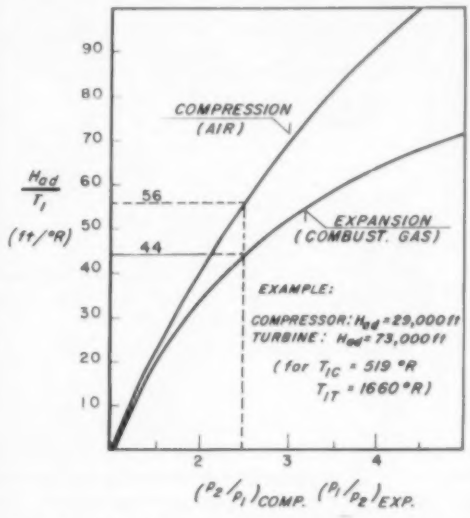
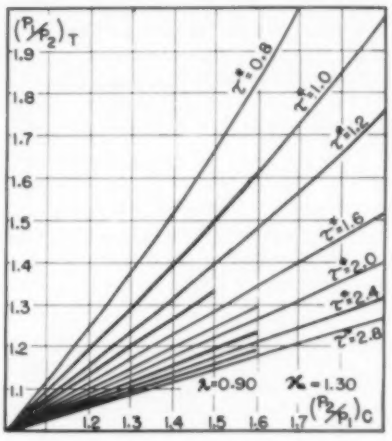


FIG. 1a. Turbine and compressor adiabatic work factor vs pressure ratio of expansion and compression.



$$P_c = \frac{W_c \cdot H_{ad-c}}{550 \cdot \eta_c} \text{ [hp]} \qquad W_t = b \cdot W_c$$

$$P_t = \frac{W_t \cdot H_{ad-t} \cdot \eta_t}{550} \text{ [hp]}$$

$$\eta_t \cdot \eta_c \cdot \frac{T_{gas}}{T_{air}} = \tau^* =$$

$$\frac{1}{b} \cdot \frac{\chi(\chi^*-1)R\left[\left(\frac{p_2}{p_1}\right)^{\frac{\chi-1}{\chi}} - 1\right]}{\chi^*(\chi-1)R^*\left[1-\left(\frac{p_2^*}{p_1^*}\right)^{\frac{\chi^*-1}{\chi^*}}\right]}$$

FIG. 1b. Turbine vs compressor pressure ratio with turbocharging quality factor "τ" as parameter; pertinent formulas.

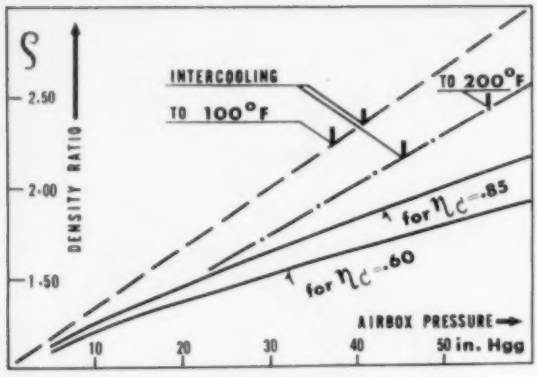


FIG. 2. Influence of intercooling on air-box pressure.

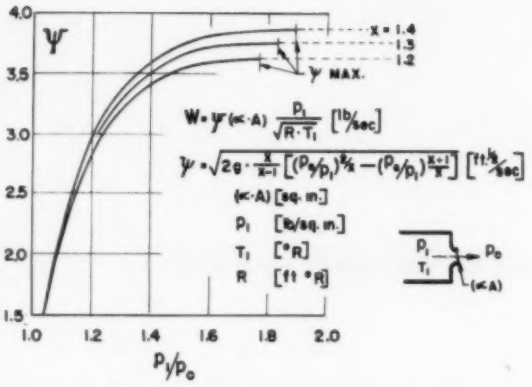


FIG. 3. Flow factor vs pressure ratio.

If the charge air would be cooled to 150F (for instance, by ambient air of 90F), the inlet manifold pressure would only need to be 50 in. mercury absolute (or the compressor pressure ratio 1.67) to obtain the same charge-air density. That means less turbocharger performance would be required. Fig. 2 shows the influence of intercooling on turbocharger pressure ratios.

For 2-stroke engines and to some degree for 4-stroke engines with valve overlap in the order of 100 and higher, engine air flow follows somewhat other laws. With regard to air flow, these engines have no longer "constant displacement" characteristics. Air flow through such engines can therefore not be determined from equations 1 and 2.

With respect to air flow, two-stroke and highly overlapped four-stroke engines have characteristics similar to an orifice as shown on Fig. 3. That means engine air flow follows the law for orifice flow or with a simplified term arrangement.

$$W = 8.2 \times k \times A \times P_1 / \sqrt{T_1}$$

where: w = engine air flow, lb/min

k = a factor highly sensitive to changes of the ratio between inlet and exhaust manifold pressure

p = inlet manifold pressure, in. mercury absolute

T = inlet manifold temperature, Rankin

As Fig. 3 shows, "k," or ψ, equals 1.7 for a scavenge differential of 1.05 and approaches 3 for scavenge differential of 1.2.

"A" represents an equivalent orifice area and can be determined as a numerical factor from any condition for which W, p_1, p_2 (the pressure in the exhaust manifold), and T_1 are known. "A" remains approximately constant for each engine speed. The air flow for any other set of conditions in the inlet and exhaust manifold can be determined with fair accuracy by using the same "A" value.

As a rule of thumb for the determination of engine air requirements, 4.5 to 5 hp are obtained from 4-stroke engines per lb per min of charge air. Most 2-stroke engines yield 3 to 3.5 hp per lb per min of charge air.

Not always will the ratio between the output of a turbocharged engine and the output of the corresponding non-turbocharged engine model (or the "power ratio") be the same as the density ratio of turbocharging. The reasons for this may be as follows:

1. Volumetric efficiency of the engine without design modifications is essentially improved by turbocharging as a result of reduced induction losses.

2. Volumetric efficiency of the turbocharged engine version is higher than that of the non-turbocharged version due to design modifications such as increase of number of valves, valve area, etc.

3. Turbocharged engine version has higher valve overlap than the non-turbocharged model.

4. Engine uses a "Büchi"-type turbocharging system allowing to utilize exhaust pulsations to promote scavenging.

How the engine is affected by turbocharging

Increasing the air density in the engine inlet manifold means increasing the manifold pressure with a concurrent increase of manifold temperature. Cooling the charge air subsequent to compression will minimize the temperature rise so that the same density can be obtained at a lower pressure level. This, of course, is favorable as far as engine mechanical loads are concerned (lower engine cylinder pressure level).

Since for a 50% density increase at 90F ambient temperature the engine inlet manifold temperature approaches 230F, intercooling between turbocharger and engine inlet manifold would be a must for gas engines to prevent detonation.

With regard to pressure conditions within the engine, similar considerations apply: Again for a near-ideal engine with good combustion characteristics in non-turbocharged operation, end-of-compression and firing pressures and, therefore, "static" stresses on engine parts would be increased with increased manifold pressures.

However, for most engines in field service, combustion will be improved as a result of turbocharging. This results in a lesser and more gradual pressure rise from the end-of-compression to the firing pressure level. Because of this, even if end-of-compression pressures will be higher, the pressure rise gradient to engine peak pressure may be smaller in turbocharged operation.

Engine-turbocharger matching

First consider the cooperation of engine and turbocharger, assuming that there are no special controls provided either on the engine (such as changing the usual linear relationship between engine speed and rate of fuel injected) or on the turbocharger (speed limiter, variable nozzle). Generally speaking, then, in applying a turbocharger to an engine, the turbine nozzle ring will be selected so that the turbocharger design speed will be reached at the rated speed of the engine at maximum load.

Operating the engine at decreasing speeds and, for instance, at full load (along the smoke limit with maximum permissible exhaust temperatures) will result in a decreasing turbocharger speed and, consequently, in decreasing density in the engine inlet manifold. Obviously, for engine part loads, the reduction of turbocharger speed and inlet manifold density will be more accentuated.

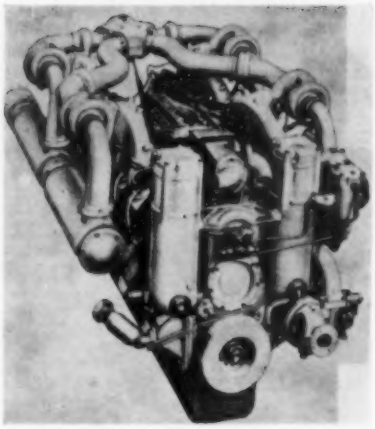


FIG. 4. Quadruple multi-turbocharger installation.

Optimum engine torque characteristics could be obtained if, for any engine part speed, the turbocharger could be made to operate at its design speed. Utilizing all available exhaust energy, this would require a continuous reduction of turbine nozzle ring area with decreasing engine speed. If only part of the engine exhaust gas flow would be used, higher turbine inlet or engine back pressures would be required for a certain compressor discharge pressure or density ratio required.

If this is permissible, use of the "speed limiter" or gas blow-off valve represents a simpler alternative to turbine nozzle area variation. With the speed limiter, a turbine nozzle ring of fixed, relatively small area, resulting in relatively high turbocharger output already at engine partial speeds, is used. This device senses the pressure ratio across the turbocharger compressor (or could be made to sense turbocharger speed directly) and wastegates exhaust gas when this pressure ratio reaches a level corresponding to turbocharger design or maximum permissible speed. With increasing engine speed, the "speed limiter" blows off an increasing portion of total gas flow.

Application of turbochargers to 2-stroke engines

Turbocharging of 2-stroke engines can be achieved in two basically different ways:

1. By operating the turbocharger in series with the mechanical blower or scavenge pump with the turbocharger installed upstream of the blower.

2. By "pure" turbocharging without use of the mechanical blower.

Since most 2-stroke gas compressor engines have relatively low exhaust temperatures and since they are not "self aspirating," retaining the mechanical scavenge blower will, in the majority of applications, be preferable or necessary to properly scavenge the engine at low speeds and loads where there would not be sufficient exhaust energy available for the turbocharger to maintain a positive "scavenge differential." Especially for retrofit engine conversions, this approach would appear to be the most practical one since it would not require any major engine changes. In most cases the matching of turbocharger and mechanical blower represents no problem.

At high engine speeds and loads, there is then a possibility to "unload" the mechanical blower with the turbocharger installed. If the blower inlet volume flow would attain a value at which the blower pressure ratio would be zero, the power consumption of the mechanical blower would also be zero.

For such complete "unloading" of the mechanical blower, a relatively high turbocharger over-all efficiency would be required since with the turbocharger only, and with the relatively low gas temperatures typical of 2-stroke engines, the air box pressure would have to be higher than the turbine inlet pressure in order to maintain adequate scavenging. Worthwhile partial unloading may, however, be obtained even with moderate turbocharger over-all efficiencies.

Intercooling of the charge air between the turbocharger and the mechanical blower should always be considered for turbocharger applications to engines of the larger size category. Apart from its favorable influence on inlet manifold density, intercooling will help to keep the blower inlet temperature within safe limits.

"Pure" turbocharging of 2-stroke engines, with or without mechanical drive assists from the engine for starting purposes, presently is limited to marine and stationary 2-strokes of the larger size class. Systems of this kind will in most cases require careful "tailoring" of the turbocharger to the engine. The majority of "pure" turbocharging systems for 2-stroke engines is of the pulse type. In such systems the dynamic energy of exhaust gas pulsations is utilized to promote the scavenge air flow.

Single vs multi-unit installation

From a viewpoint of a maximum degree of exhaust energy utilization and the minimization of duct losses, fitting each cylinder with a turbocharger would naturally be the optimum solution. As shown on Fig. 4, there exist installations which go pretty far in the direction of this approach.

Other obvious advantages of multi-turbocharger vs single turbocharger installations are the following:

1. Better engine transient load and starting characteristics due to the faster response rate of smaller turbochargers with their low rotor inertia.

2. Emergency capability in case of failure of one turbocharger: the other units will allow continued engine operation at reduced load.

3. Easier maintenability: installation and removal of turbochargers is significantly facilitated when their size and weight are small. Spares can more easily be kept ready at hand and brought to location in case of an emergency.

4. Small turbochargers can be mass produced; thus, the installation of small turbochargers in multiples on an engine can be effected at a fraction of the cost of installing one large turbocharger.

Whereas about 15 years ago the efficiency argument was often brought up in discussions of small vs large turbomachinery, developments in small and miniaturized turbomachinery since then almost devalidate this argument today.

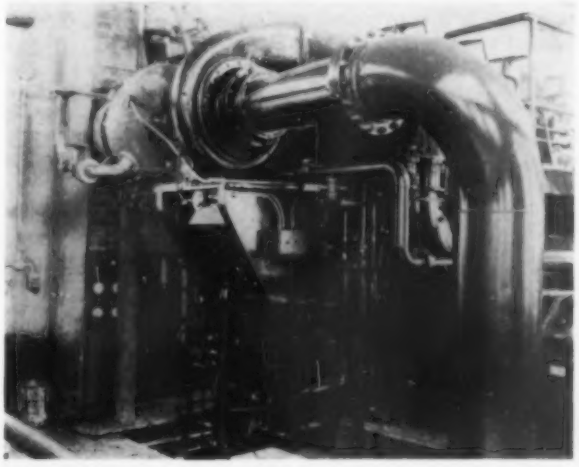


FIG. 5. Single turbocharger installation on gas compressor engine.

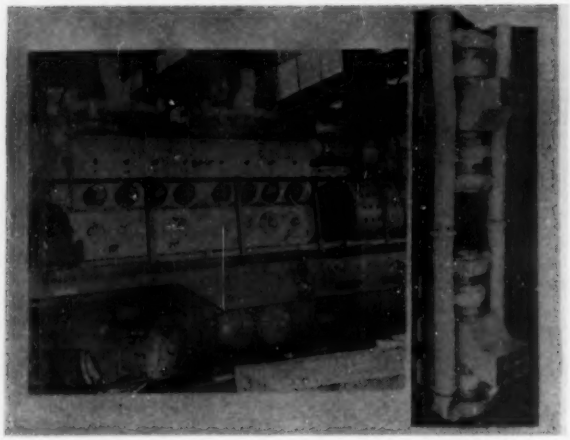


FIG. 6. Multi-turbocharger installation on locomotive engine.

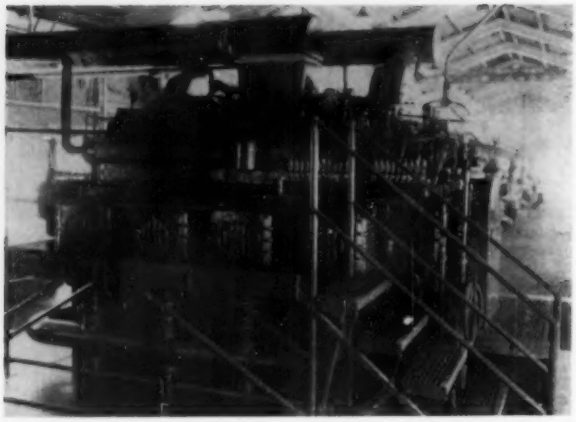


FIG. 7. Multi-turbocharger installation on gas compressor engine.

In the size range above 12-in. wheel diameter, turbomachine efficiencies may surpass 85%. However, even down to 3-in. wheel diameter, efficiencies can still be held around the 80% level as a result of advances in turbomachine design theory.

Degree of power boost and resulting engine stresses

Power boosts as high as in the order of 100% by turbocharging have been achieved on large, marine two-stroke diesel engines, thus marking the ultimate possibilities of this method of power boosting. Turbocharging of smaller gasoline engines, with power boosts from 20 to 30%, would define a lower limit. For gas compression engines power boosts would, in most cases, occupy the medium range, say, from 30 to 50% with the compressor part of the engine being, in general, the limiting component.

With regard to the power cylinders of the engine, boost limits are determined by the mechanical and thermal conditions as a result of turbocharging.

Cylinder heat load is a function of the mean process temperature and of the mean heat transfer coefficient from the gas to the cylinder walls. Thus, in order to keep heat load constant, the gas temperature would have to slightly reduce since the gas heat transfer coefficient increases with temperature and pressure. Or, if turbocharging results in an increase of the mean value of all process pressures, operation should be at a slightly higher air/fuel ratio. Increased charge density furthermore increases engine cooling efficiency. Another reduction of heat load is attributable to the lower temperature of the charge at the beginning of compression due to improved scavenging of residual combustion gas when turbocharging.

For a power or charge-air density increase of 60% maximum cylinder pressures may not be increased by more than 20% by virtue of improved combustion conditions, as tests on European diesel engines have shown. This is a major factor in favor of turbocharging as well as of supercharging in general.

With regard to thermal loads, statistical experience has shown that with power increases in the order of 30% to 40% as applicable to gas compression engines, the thermal loads on critical engine parts were not at all higher than those in the non-turbocharged engine.

Installation, maintenance and cost

To make a turbocharger retrofit installation a success, certain ground rules should be observed.

Let's consider gas flow first. As as a rule of thumb, about one-third of the Btu input to the engine is converted to useful shaft power, one-third is rejected to the cooling water, and the remaining third is normally waste energy in the exhaust gas. Thus the turbocharger works with roughly the same percentage of Btu input to the engine as is converted by the engine into shaft power.

Note that utilization of this exhaust energy takes place in a space not larger than required by an average size air filter. This emphasizes that the flow of exhaust gas through the turbine and of combustion air through the compressor must take place in a highly organized way to result in an efficient energy exchange from exhaust gas to combustion air.

In view of this, a turbocharger's best performance can only be obtained if the "external" flow processes also take place in a similarly smooth and well ordered manner. "External" flow refers to processes of a transitional character taking place in the intake, delivery and exhaust ducts, especially in the immediate vicinity of the turbocharger.

Every designer worth his salt takes considerable pains when laying out an inlet manifold system for a new engine. The turbocharger duct system would seem to deserve the same treatment. If this philosophy is followed, chances of a pitfall in making a "retrofit" turbocharger installation are minimized. It will be well worthwhile to bear this in mind durng all phases of a retrofit installation.

One of the first questions likely to be asked by the operator considering a retrofit or "kit" conversion will be: "How will the turbocharger, intercooler and duct work fit into my already-too-crowded installation?" Fortunately, in multiple installations turbochargers are relatively small thus providing considerable flexibility in their placing. However, earlier comments regardng gas flow must be kept in mind when planning the installation.

Considering relative size of engine and turbocharger, this ratio may be somewhat different for 4-cycle versus 2-cycle engines. For the same displacement and rpm, 2-cycle engines require up to three times more air than 4-cycle engines. However, the inherent design flexibility of radial compressors as used in turbochargers is such that a three times greater flow can be obtained by an increase of wheel diameter not greater than about 25%.

Whether this increase would be reflected in over-all diametral space requirements of a turbocharger depends entirely upon its design. If, during design, emphasis was on small size, most of the wheel diameter increase naturally would be reflected proportionally in an increase of over-all diameter. However, turbochargers designed with ruggedness and low cost as primary objectives may allow doubling and even tripling of capacity without significant increases of over-all dimensions.

Relative space requirements of a single vs a multiple

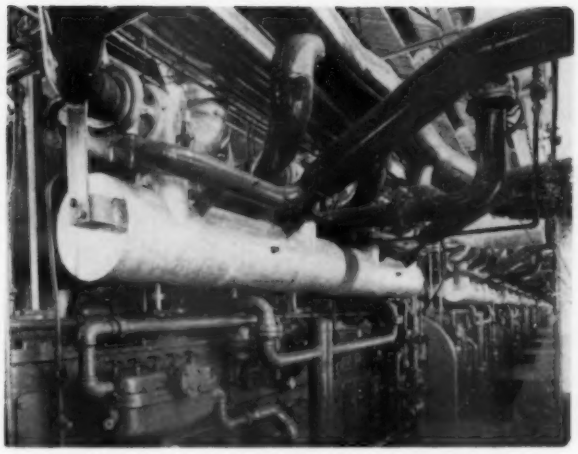


FIG. 8. Large scale turbocharger retrofit installation.

turbocharger installation are demonstrated in Fig. 5 and 6.

The retrofit installation of two turbochargers, as shown in Fig. 7, provided an engine power boost from 280 hp at sea level to 335 hp at 1800-ft altitude. The engine is a typical 2-cycle, spark ignition natural gas pumper. In this installation the scavenge cylinders were retained to assist in starting and idling. Some key performance and operational data are listed in Table 1.

Table 1.

	Non-Turbocharged	Turbocharged
Output (hp)	280	355
Speed (rpm)	600	600
Brake Mean Effective Pressure (psi)	59.6	73
Air Flow (ppm)	75	108
Av. Peak Firing Pressure (psig)	435	510
Scavenge Cylinder Number	4	3
Scavenge Cylinder Pressure Ratio	1.22	1.08
Scavenge Air Pressure (in. Hg)	6	12
Spec. Air Consumption (lb/hp-hr)	16	19.7

It was observed in this installation that turbocharging reduced the cooling load about 40%. Engine exhaust gas temperature (turbine inlet) was in the order of 870 F to 930 F.

Fig. 8 shows a large scale retrofit installation of four small turbochargers per engine recently accomplished in a California natural gasoline plant. As of this date about 9000 additional gas pumping horsepower were obtained at this plant by retrofit multi-turbocharger installations.

Hardware requirements

Turbocharger

For most in-line engines the turbocharger will have a single turbine inlet and compressor discharge (Fig. 9). For larger vee-type engines turbochargers with double turbine inlets to accommodate separate groups or banks of cylinders are being marketed (Fig. 10).

Turbochargers with single turbine inlets may still have subdivided turbine housings to avoid harmful interaction of exhaust pulsations and scavenging periods. For this purpose one provides separate openings in a single turbine inlet flange to fit a "split" exhaust manifold (Fig. 11).

Exhaust manifold

Since the exhaust temperature of typical 2-stroke gas pumping engines is rather low and since, particularly for starting and part-load operation, the energy in the engine exhaust is marginal for "pure" turbocharging operation, careful conservation of this energy is essential. The usual water-cooled exhaust systems on this type of engine should therefore be replaced by well-insulated exhaust ducts between engine and turbocharger such as shown on Fig. 12.

Use of expansion joints will prevent the introduction of any duct forces caused by thermal expansion on the turbocharger housing. To protect the high-speed rotating assembly of the turbocharger from damage by foreign objects, provision of stainless-steel screens in the exhaust ducting at the turbocharger inlet is good preventive practice.

Turbine discharge duct

This is a most critical part of any turbocharger retrofit installation. Abrupt bends or small size of this duct will result in back pressure on the turbine. Even if this is relatively small it will reduce turbine performance and produce a disproportionally greater increase of engine back pressure. Experience shows that nearly all benefits of an engine conversion can be wiped out if the turbine is "strangled" by back pressure.

Therefore, duct size downstream from the turbine should be such that back pressure at the turbine outlet equals, for all practical purposes, atmospheric pressure. Fig. 13 shows how the turbine discharge system is most amply dimensioned in the form of a plenum chamber.

Air intake system

Comments with regard to pressure losses in the turbine exhaust duct also apply to the air intake ducting and air filter. Any flow restrictions should be avoided. Assume a turbocharger designed to operate with a pressure ratio close to 2:1 as necessary to obtain a 50% increase in charge-air density or engine power. Then, if the pressure loss in the air intake system were in the order of .75 psig, a 5% reduction in power boost would result. Therefore, the pressure drop through the air intake filters should be within 1 to 3 in. of water.

FIG. 9. Turbocharger with single turbine and compressor inlets.

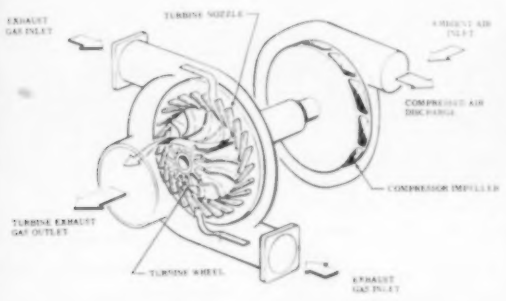


FIG. 10. Schematic of turbocharger with double turbine inlets.

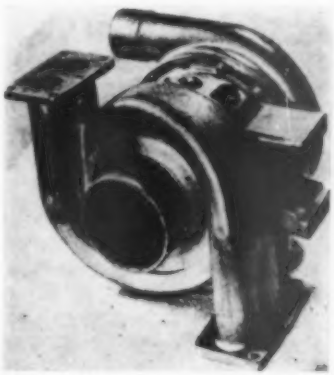


FIG. 11. Turbocharger with split turbine inlets.

FIG. 12. Exhaust ducting modification on gas compressor engine.

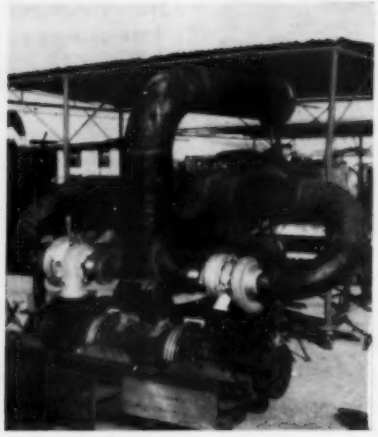


FIG. 13. Turbine discharge plenum for twin turbocharger installation on gas compressor engine.

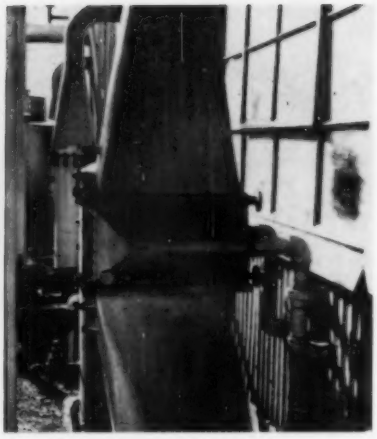


FIG. 14. Charge-air intercooler.

Pressure air duct

Configuration and size of the air duct between the compressor discharge flange, the intercooler and the engine inlet manifold must also be such as to minimize flow losses.

When locating the turbochargers and pressure air duct, attention should be given to minimizing the inflow of heat to the air delivery system by conduction or radiaton from hot engine parts. Any increase of charge-air temperature will, of course, decrease its density and thus reduce the effectiveness of turbocharging.

Charge-air cooling between the turbocharger and the engine is practically achieved in air-to-water heat exchangers as shown in Fig. 14. These heat exchangers should have removable cores for cleaning. Hydrostatic leak tests and efficiency checks for this component should be made at 10,000-hr intervals. Again, for the pressure air duct system, the general rule should be followed to fit all such duct work with flexible joints.

Lubrication and cooling of turbocharger

Since most turbochargers do not have a self-contained lubrication system, connections to the engine lubricant circuit or provision of a separate lube system must be made.

Oil flow through a turbocharger is often only a small percentage of the oil flow through the engine. In a 200-hp engine case, for example, oil flow through the turbocharger would only be a small fraction of one gpm.

Detailed instructions with regard to the size of the turbocharger oil supply and drain lines will be found in most installation directives. Special attention should always be given to the ample dimensioning of the oil return line utilizing gravity effects. A sight glass in the turbocharger drain line is a reassuring device to include in any installation. In view of the very small bearing tolerances in high-speed turbomachinery, utmost care should be exercised in keeping the turbocharger lube system clean. Fine filters for turbocharger lubricant in series with the engine oil filters are a definite must.

Controls

As seen, a turbocharger adapts itself freely to varying engine loads and speeds. Generally speaking, there is therefore no need for controls once the best turbine nozzle ring for certain performance characteristics has been selected and installed.

Under certain conditions, however, some limit controls for turbocharger speed may become necessary. They may consist of a gas blow-off valve between the exhaust manifold and turbine inlet.

Built-in turbocharger controls, such as a variable area nozzle ring, may be more widely accepted in the future despite design complication and higher cost. Such controls will allow fullest utilization of inherent turbocharger capabilities, particularly for engines operating at varying conditions.

Engine modifications

There is a rather widespread misconception that power increases by turbocharging would generally result in higher engine stresses and that, therefore, retrofitting of turbochargers would always require rather extensive and costly engine modifications.

In most cases where retrofit turbocharging is contemplated, the engines, even at their lower "naturally aspirated" power level, are operating under load and environmental conditions more severe than those for which they were designed. In this case, the beneficial influence of improved engine "breathing" as a result of turbocharging will counterbalance the influence of operating at a higher power level. In consequence, engine stresses will quite often not at all be higher in turbocharged than in naturally aspirated operation and there will be no need for engine modifications.

As discussed above, another important aspect to consider is the manner in which power increases by turbocharging are obtained. Most older stationary engines have rather mediocre volumetric efficiencies. Therefore, a relatively high power boost can be obtained with a comparatively small increase in charge-air pressure or an even smaller increase of charge density. (For instance, 30% power increases have been obtained on a marine diesel engine with a pressure ratio of only 1.25 resulting in a density increase not larger than 15%.)

On the other hand, if the naturally aspirated engine has a good volumetric efficiency, then the power increase will be in rather close proportion to the increase in charge density and the charge pressure level to obtain this power increase will correspondingly be higher.

It is obvious that in the first case considerable power boosts can be obtained with practically no increase in internal engine stresses — more often than not even with a decrease — whereas in the second case mechanical improvements to some engine components may be good practice.

Depending on the magnitude of the power increase the following engine modifications may be considered:

1. Reduction in compression ratio to limit engine peak pressures.

2. Increase of valve timing to improve cylinder scavenging.

3. Increase of bearing load capacity (for instance, by

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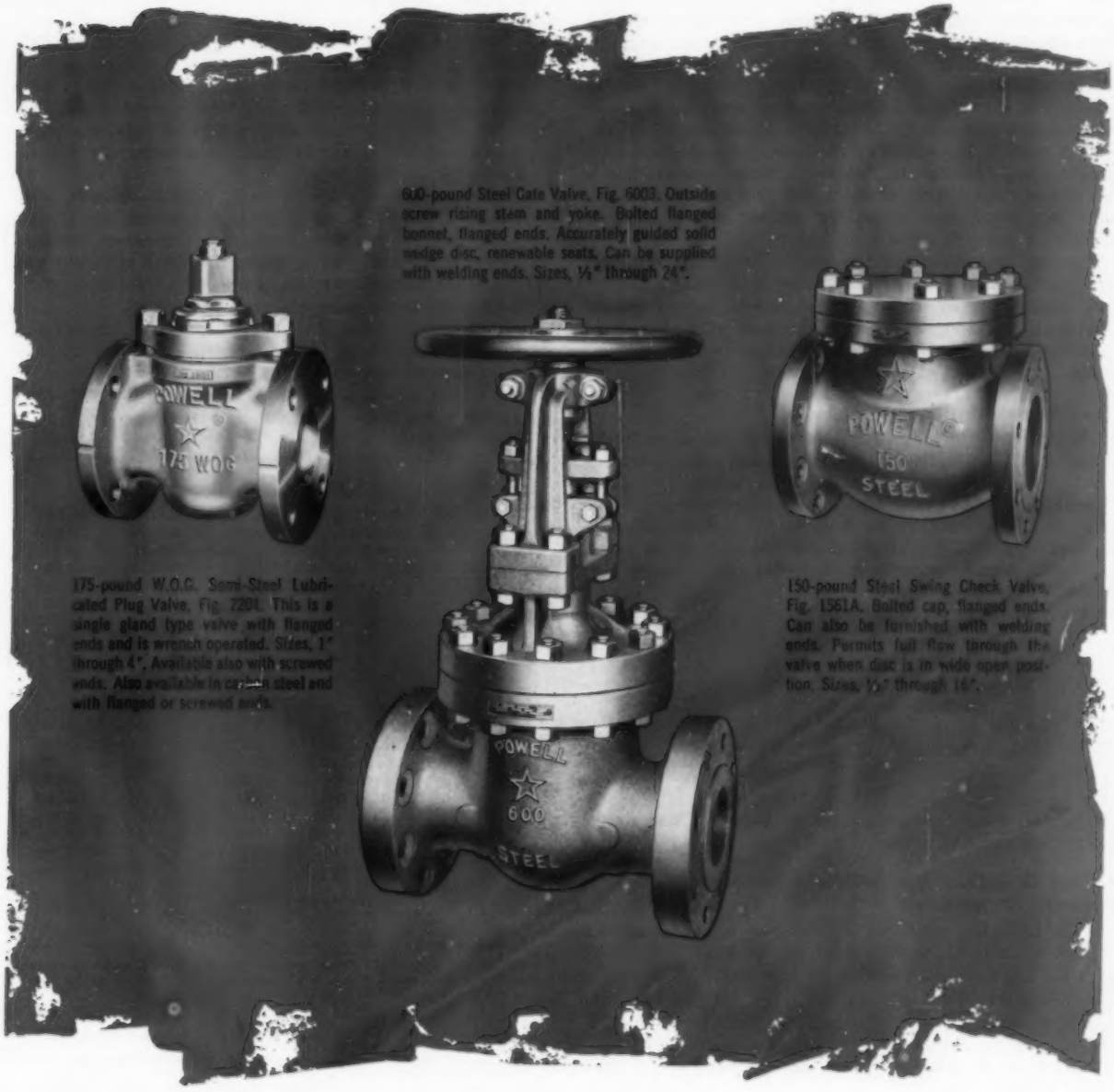

600-pound Steel Gate Valve, Fig. 6003. Outside screw rising stem and yoke. Bolted flanged bonnet, flanged ends. Accurately guided solid wedge disc, renewable seats. Can be supplied with welding ends. Sizes, ½" through 24".

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replacement of Babbitt type by aluminum bearings). This measure entails the provision of a prelubrication assist pump with a separate drive and of finer lube oil filters (five microns). Also, with aluminum bearings, a new main engine oil pump having 30% more capacity should be installed on smaller engines.

4. Changes to engine ignition. Retarding of timing may be indicated, and provision of a dual ignition system further improves engine operation and detonaton characteristcs.

Of these modifications, only the fourth seems to be mandatory for gas compressor engines. Necessity for the others is of a more secondary character to be decided upon from case to case.

For engines of the 2-cycle gas pumping type, the exhaust energy during starting and low load levels is insufficient for self-sustained turbocharger operation. For retrofit multi-turbocharger installations this predicament can be overcome by having compressed air impinge on the turbocharger rotor parallel with ignition regarding. Also, the engine scavenging pumps can be retained and operated in series with the turbochargers. Since, at full-load operation, the pumps will be "unloaded" by the turbochargers (increasing their through flow to the "no-pressure-rise" point), this is a recommendable method which will also always provide a safe engine scavenge differential in case of turbocharger failure.

On the side of the gas compressor cylinders, sometimes idle cylinders or cylinders operating at reduced capacity, are available to utilize the increased engine output. Added clearance or liners can then be removed with consequent chrome plating of the core and fitting of new pistons and rings.

Instrumentation

It goes without saying that any retrofit turbocharger installation should comprise a well thought out system of instrumentation providing adequate safety shut-down features. Pressure and temperature gauges with adjustable electrical contacts may serve as safety switches effecting magneto grounding and gas shut-off in case of an emergency. Important monitoring data for the turbocharging system would be as follows:

1. Turbine oil pressure
2. Engine oil pressure
3. Scavenging air pressure
4. Intake manifold pressure
5. Intake manifold temperature
6. Exhaust gas temperature
7. Intake to exhaust manifold pressure differential

This instrumentation would, of course, be in addition to the normal engine and gas compressor monitoring data such as engine speed, cooling water temperature, compressor interstage and final pressures and temperatures.

What is achievable with a multi-turbocharger retrofit installation

The following results which were recently obtained in a California natural gasoline plant can be considered typical for the large scale application of retrofit turbocharging to gas compression equipment:

Total power increase (22,790 to 31,135 bhp)	37%
% cost per hp increase by turbocharging to cost per hp increase by new power equipment	50%
Fuel savings (average)	15%
(maximum)	27%

When it is considered that, in this case, 8,345 hp were made available by retrofit turbocharging without any new capital expenditures for additional foundations, buildings, increased cooling water supplies and processing plant and that, furthermore, this horsepower increase resulted in decreased maintenance and operating expenses in contrast to the increased maintenance cost when adding new prime movers, the merits of this approach will be fully appreciated.

In addition to these primary advantages gained, the essential improvement of the operational characteristics of the old gas compression machinery as a result of turbocharging (capability to accept rapid load increases, reduction in cooling water requirements, smoother combustion, etc.) will be found to be nearly of equal importance for most operations.

Reliability

In concluding, a word regarding the reliability of smaller highspeed turbomachinery such as turbochargers for multiple retrofit installations on gas compression engines seems to be in order.

Turbochargers of the smaller size as used for multiple retrofit installations on gas compression engines run at 30,000 to 50,000 rpm. Their journal-type bearings have repeatedly accumulated running times up to several ten thousands of hours making this type of turbomachinery good for several years of continuous operation without bearing replacement.

Turbochargers will thus be found to be dependable, loyal servants in many power applications within the Hydrocarbon Process Industry, paying for themselves within a short time, contributing to better operating efficiency and economy, relieving operators from many traditional prime mover and compression equipment problems.

Of course, the success of any new technological approach will always depend on a good measure of enthusiasm, conscientiousness and alertness. To meet the challenge of reaping the substantial benefits of retrofit turbocharging calls for rather ample measures of these virtues.

ABOUT THE AUTHOR

Hans K. Ziebarth is a corporate staff engineer for The Garrett Corporation, Los Angeles, where his is principally concerned with industrial adaptation of high-speed, small turbomachinery such as gas turbines, compressors and expansion turbines. A native of Germany, he studied at the Technical Universities of Munich and Berlin and holds a diploma in mechanical engineering. For close to 25 years he has specialized in small turbomachinery for aircraft and automotive applications, with emphasis on internal combustion engine supercharging and turbocharging. After coming to the United States in 1946, Ziebarth became a project engineer and consultant on turbomachinery accessory systems. He was originator of eight major exhibits for government-sponsored research contract in the area of miniaturized turbomachinery, supersonic compressors, heat transfer, aircraft accessory systems, and turbomachine dynamics. He joined Garrett in 1955. While in Germany Ziebarth worked for seven years at the Institute of Aeronautical Research at Berlin-Adlershof (DVL) on turbocharging systems for high-altitude aircraft powerplants and army utility vehicles.

References

1. Büchi, A. J. "Exhaust Turbocharging of Internal Combustion Engines" Monograph No. 1, published under the auspices of the Journal of the Franklin Institute, July 1953.
2. Gotterba, C. E. "Need More Power? — Convert by Turbocharging" *Diesel Power* June 1958, p. 16, and July 1958, p. 73.
3. Gotterba, C. E. "Maintenance of Converted Supercharged Gas Engines" *Gas* Dec. 1957, p. 97.
4. Anon. "Multiple Turbocharging of Gas Engine Compressor Units" *Diesel Power*, June 1959, p. 30.
5. von der Nuell, W. T. "Notes on Turbocharged Two-Stroke Cycle Diesel Engines" SAE Paper No. 799 (1956).
6. Birman, R. "Aerothermodynamic Considerations Involved in Turbocharging Four- and Two-Cycle Diesel Engines" ASME Paper No. 55-0GP-10.
7. Chamberlain, C. A., & Boilman, G. H. "Turbocharging Two-Stroke Gas Engines" ASME Paper 54-0GP-7.
8. Kauffman, W. M., & Schultz, D. E. "Development and Application of a Small, Four-Cycle Turbocharged Gas Compressor Engine" ASME Paper No. 59-0GP-1.
9. Hines, J. D., & Reed, N. "Turbocharging Development for Loop-Scavenged Two-Cycle Gas Engines" ASME Paper No. 57-0GP-4.
10. Clark, L. E. "Value of Intercooling" *Diesel Power* Aug. 1958, p. 14.

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R. N. MADDOX, P.E., W. A. FLING, JR., P.E.,

Dr. Robert N. Maddox, professor and head of the School of Chemical Engineering at Oklahoma State University, has accomplished important research in distillation using a medium sized computer. Maddox has been on the Oklahoma State faculty since 1950, except for a period from May 1951 to September 1952 when he was a design engineer in the process division of Black, Sivalls & Bryson, Inc., Oklahoma City. He has a BS in chemical engineering from the University of Arkansas, MS from the University of Oklahoma, and PhD from Oklahoma State and is a registered professional engineer in Oklahoma.

Wayne A. Fling Jr. as computer engineer is responsible for computer applications for the gasoline division of Cities Service Petroleum Co. Fling, who holds a BS in chemical engineering from the University of Kansas, joined Cities Service in 1954 as a gasoline division process engineer in the Bartlesville, Oklahoma, offices. He held the positions of project engineer and operations superintendent of the Chico gasoline plant before assuming his present post. Fling is a registered professional engineer in Oklahoma and is an associate member of the American Institute of Chemical Engineers.

LET'S TAKE A LOOK at the impact of digital computers in making distillation calculations. Rigorous procedures have been emphasized almost to the point of excluding short-cut and/or empirical type calculations. In many cases it is easy to justify the investment of computer time that is required to make rigorous distillation calculations. In other cases, such an investment of time is borderline at best, and may really be unwise and uneconomical.

Plant simulation programs are currently receiving a great deal of attention. In these programs, the engineer attempts to develop a mathematical model or series of mathematical models that will adequately represent plant performance. In many simulation programs, base conversion yields are calculated much more carefully than are finished product yields. This approach is undoubtedly justified when considering rigorous distillation calculations. Accurate short-cut procedures, however, do not require so much computer time and will provide a good estimate of finished product yield in a plant simulation program.

In conventional distillation calculations, the column is considered to be made up of a number of theoretical plates or stages as shown in Fig. 1. Calculations for the unit, then, either consist of a series of plate calculations or some method designed to approximate plate performance by a short-cut or empirical calculation.

Fig. 2 is a schematic diagram of an equilibrium flash separator. The vapor and liquid streams leaving the separator are in equilibrium with each other and are related through the convention equilibrium relationship.

$$y = Kx \quad . \quad . \quad . \quad (1)$$

Equilibrium constants, or K′ values are determined experimentally by obtaining samples from vapor and liquid streams in equilibrium with each other. Values of y and x are measured by analysis and the equilibrium constant calculated.

Looking again to Fig. 1, we see that the distillation column produces an overhead or vapor stream and a bottoms or liquid stream. If we consider these two streams to be in "equilibrium" with each other we could calculate the equilibrium constants, K′, in exactly the same way that the conventional equilibrium constant is determined.

From plant tests, with product composition determined from stream analysis,

$$K' = \frac{x_{d_i}}{x_{b_i}} \quad . \quad . \quad . \quad (2)$$

x_{d_i} = mole fraction of component in distillate

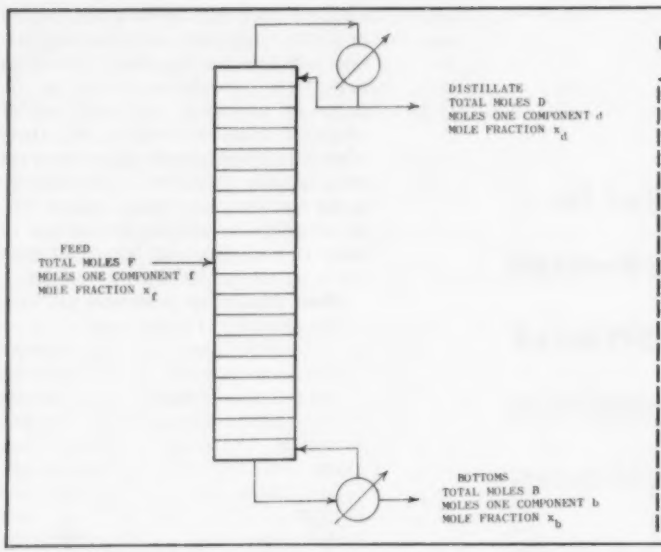

Fig. 1. Distillation column.

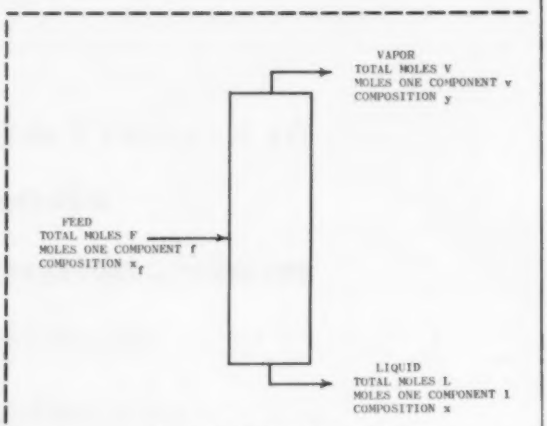

Fig. 2. Equilibrium flash separator.

x_{b_i} = mole fraction of component in bottom

The K′ would be a function of the reflux rate and number of theoretical plates in the distillation column. As long as these two variables have their original values the K′ for each component should remain constant.

This view of the operation of a distillation column was first presented by Erbar and Maddox.[1] They considered the operation of a field stabilizer with no external reflux. The K′ values they reported were functions of component volatility with column performance (expressed as a function of the distillation separation being made) as a parameter.

Peiser[2] has utilized the same concept in a more detailed way. He uses the K′ concept together with heat and material balance to develop a convergence technique for multicomponent distillation calculations. He reports that the technique gives rapid closure for both rating and design problems.

Using the proposed method of calculation in a plant simulation program would permit the calculation of product yields from base conversion yields by a series of simple flash calculations.

$$b_i = \frac{F_i}{K'\frac{B}{D} + 1} \quad . \quad . \quad (3)$$

b_i = moles of component i in bottom product
B = total moles of bottom product
D = total moles of distillate product
F_i = moles of component i in feed
K_i = pseudo equilibrium constant for component i

In using this method, the engineer must assume minor or negligible changes in tower feed composition. In the case of plant simulation programs, this would probably be the case. In a refinery simulation program, for example, feed stocks to the different fractionation units should undergo only small changes in component distribution, even when the crude oils charged to the refinery differ significantly. If large changes in feed composition occur, tower internal stream compositions will change, and this could reflect in a change in the number of theoretical plates in the column.

Table 1. Comparison of Distillate Compositions.

Component number	Distillate plant test mole %	Distillate computer results mole %
1	3.90	3.89
2	27.92	27.38
3	67.56	67.59
4	0.62	0.86
5	0.00	0.26

Table 2. Comparison of K′ Values.

Component Number	Tower 1		Tower 2		Tower 3		Tower 4	
	Test	Computer	Test	Computer	Test	Computer	Test	Computer
1	∞	∞	∞	∞	∞	∞	225.33	∞
2	71.44	142.58	∞	∞	38.63	57.95	81.04	86.60
3	0.0	0.021	∞	42.12	0.0	.01	.05	.04
4	0.0	0.0	6.84	6.79	0.0	0.0	.01	0.0
5	0.0	0.0	.027	.038	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	.011	0.0	0.0	0.0	0.0
7	0.0	0.0			0.0	0.0	0.0	0.0

To illustrate the validity and reliability of this method for predicting distillation column performance, several test cases were studied. In each case plant test data were used as a basis for comparison. Rigorous distillation calculations were carried out until a good comparison was obtained between calculated product compositions and product compositions determined by plant test.

The degree of agreement between these two sets of values is illustrated in Table 1. (For convenience, individual components will not be identified. Also, components will be listed in order of decreasing volatility, but components in different feeds will have different numbers, i.e., the first component in feed No. 1 is ethane but in feed No. 2 the first component is propane). In carrying out the computer calculations the reflux rate was fixed at the value measured in the plant test. Different values for the number of theoretical plates and feed plate location were tried. Distillate composition was used as a basis for determining the proper combination of these two variables.

In a plant test, it is virtually impossible to exert independent control of feed composition. It is possible, however, to simulate these changes by use of a computer program. To do this, we must accept that the plate to plate program is an adequate model for the full scale distillation column.

A total of four columns were studied. In each case results of computer calculations were made to compare favorably with the product composition determined by the plant test. K′ values were then calculated for both sets of product compositions. These values of K′ are shown in Table 2. The agreement in the calculated values is good except for some cases of trace compon-

ents. These trace components are difficult to determine analytically, and the plant test values could easily be in error or present in such small amounts as to be undetectable.

The feed composition to each tower was then changed slightly to simulate a change that might be occasioned by a change in the feed stock to the unit. The magnitude of these arbitrary changes and the components to which they were applied are shown in Table 3.

Product compositions that could be expected from the distillation units with these new feed compositions were calculated using the K′ value based on plate to plate calculations from Table 2. In addition, new product compositions were calculated by plate to plate calculation. In these calculations the number of theoretical plates, the feed plate location, and the reflux ratio remained the same as in the case which most closely checked the plant test data. Product compositions from these two methods of calculation are shown in Table 4. In every case there is excellent agreement. This is particularly true for components appearing in more than trace amounts. In some cases trace components may be in error by a considerable percentage. However, when this is compared to the bulk of that component in the feed, it will be seen that there is really only a small difference in the total volume of that component present in either product stream.

The distillate composition compares least favorably in the case of Tower No. 4. For this tower the second set of plate to plate calculations were carried out using α (relative volatility) values at a slightly lower pressure than should have been used. Tower pressure should have been approximately 200 lb but α values for a pressure approximately 15 lb less than this were used. Even in this case, there is a favorable comparison between distillate composition. This indicates that small changes in process conditions will not seriously affect the accuracy of compositions calculated from K′ for a given unit.

Table 3. Tower Feed Composition Mole %.

Component Number	Tower 1		Tower 2		Tower 3		Tower 4	
	O*	A*	O*	A*	O*	A*	O*	A*
1	1.65	1.50	2.02	2.02	.39	.39	2.51	2.51
2	38.25	36.40	14.52	14.52	50.26	46.26	34.80	30.80
3	8.90	9.90	39.86	35.86	8.04	10.04	8.40	10.40
4	24.45	25.45	11.48	15.48	22.79	24.79	23.13	25.13
5	7.04	7.04	11.54	11.54	4.89	4.89	7.39	7.39
6	7.08	7.08	20.58	20.58	5.49	5.49	7.38	7.38
7	12.63	12.63			8.14	8.14	16.39	16.39

*O — feed composition as determined by test
A — feed composition adjusted to simulate change in feed charge

Table 4. Distillate Composition Mole %.

Component Number	Tower 1		Tower 2		Tower 3		Tower 4	
	K′	P-P	K′	P-P	K′	P-P	K′	P-P
1	3.99	3.99	4.24	4.24	.85	.85	7.65	7.66
2	95.68	95.71	29.69	29.71	99.02	98.95	91.75	92.13
3	.33	.30	64.76	64.65	.13	.20	.56	.20
4			1.07	1.14			.04	.01
5			.24	.26				
6								
7								

K′ — Calculated by K′
P — P — Calculated by Plate-to-Plate

Acknowledgment

The authors thank Cities Service Petroleum Company for permission to use the experimental and test data reported in this paper.

Bibliography

1. Erbar, J. H., and R. N. Maddox, "Computer Analysis of Non-Refluxed Distillation Columns", presented at the Regional WPRA Meeting, 1958, El Paso, Texas.
2. Peiser, A. M. *Chemical Engineering*, July 1960, p. 129.
3. NGSMA Engineering Data Book, 1957 Ed.

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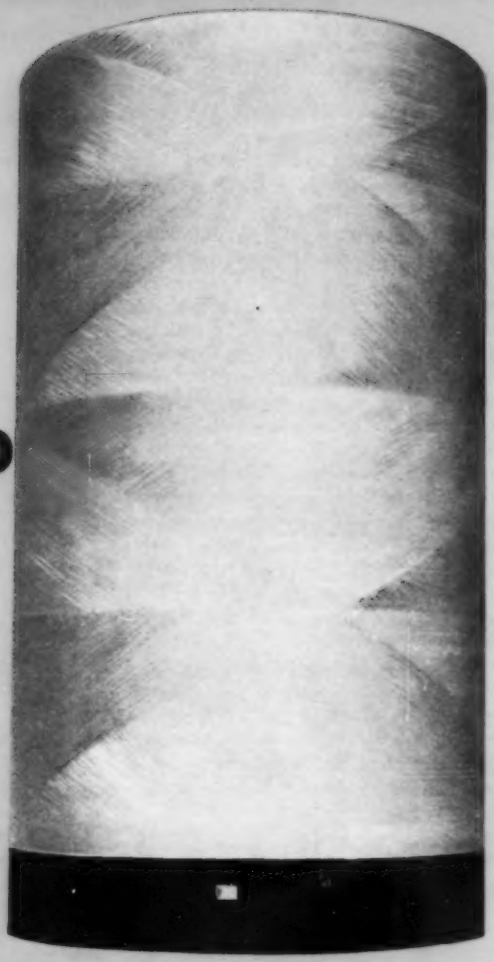

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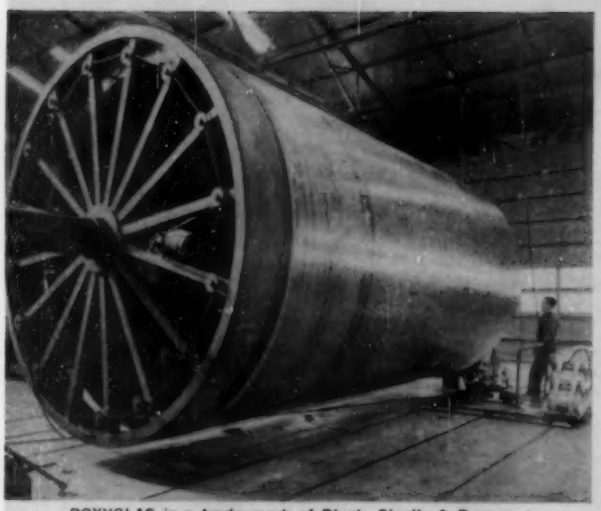

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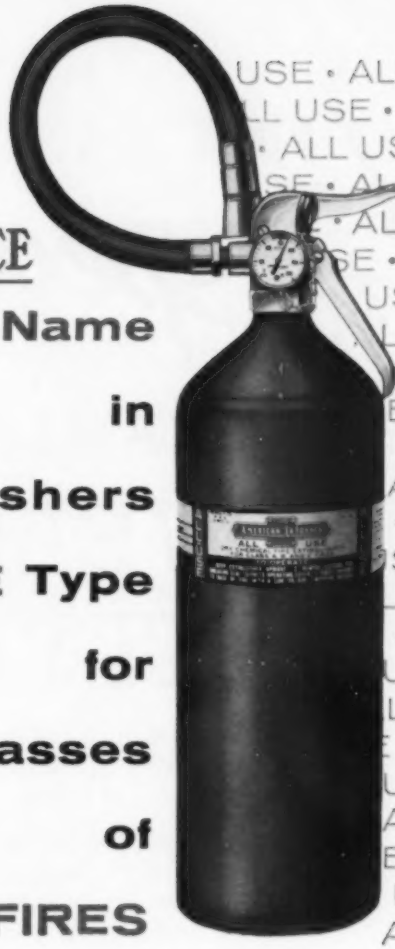

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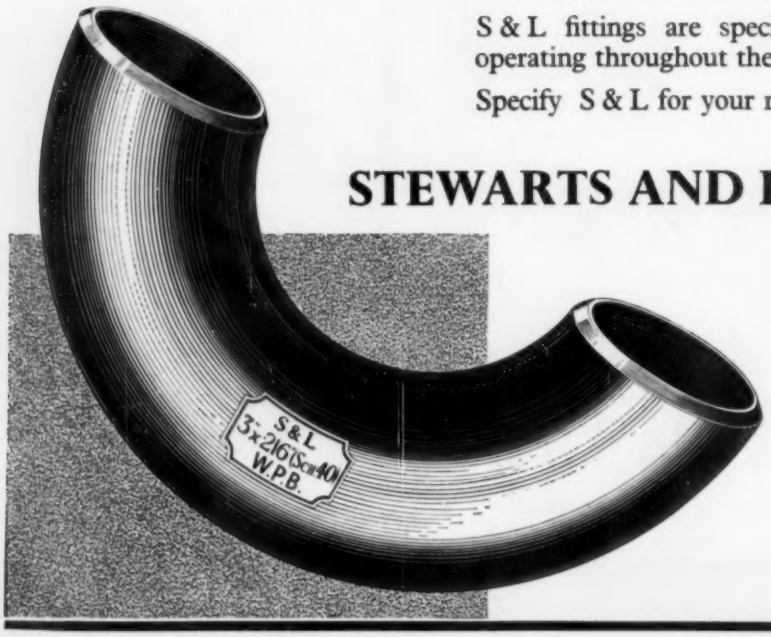

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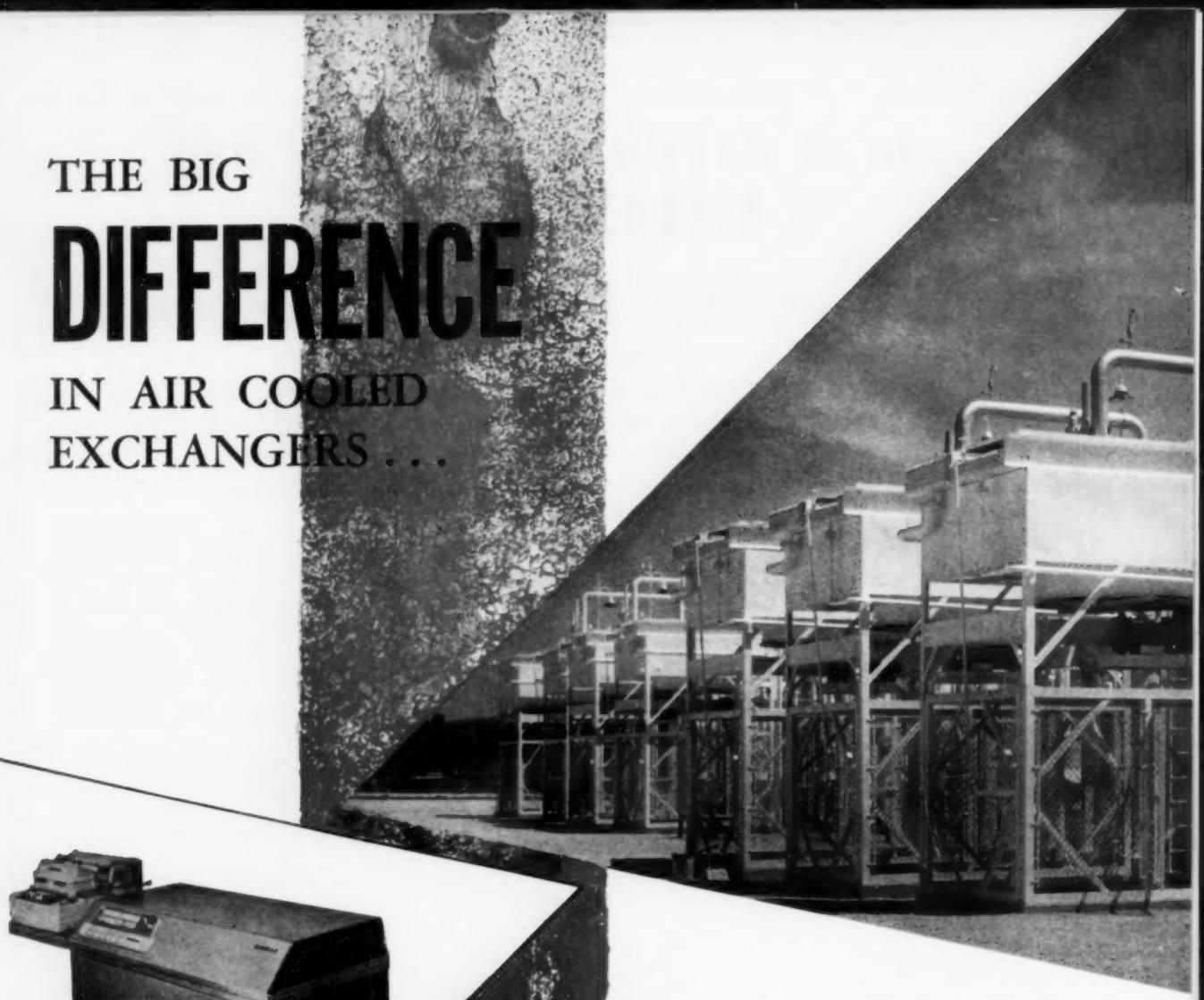

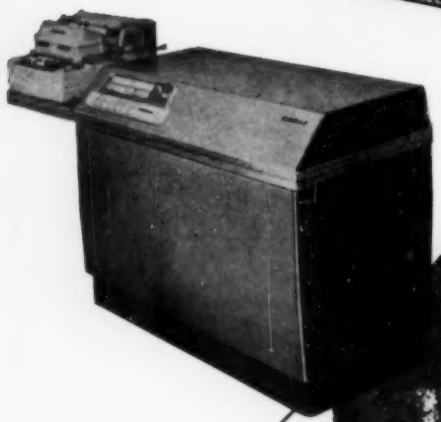

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Editor:

With reference to the article *"Exchanger Design"* by Dr. Kenneth J. Bell, p. C-26 in the October 1960 *Petro/Chem Engineer*, I would like to call to your attention the following typographical errors and omissions which appeared in the published paper.

In the equation referred to as "2" (no designation appeared) the right side of the equals sign should read, exponential **to** the minus power αF_{BP} (etc.).

Also, the ordinate of Fig. 8b should read **one** minus the pressure drop ratio rather than the negative ratio. Attention is called to the fact that Fig. 8b is used correctly in Step 18 of the example given.

The value of χ to be used in calculating h_{NL} from the "j" factor correlation is the **ratio** of χ_t for the exchanger under consideration to the χ_t for the data of **Fig. 2,** i.e., at 10 rows of tubes. Attention is called to the fact that Step 7 of the example uses the data in Table 2 in this manner.

Finally, it should be noted that the data of Bergelin, Brown and Doberstein (shown graphically in Fig. 2) defines the friction factor to include the reciprocal number of major restrictions, i.e., the number of rows of exchanger tubes in the cross flow path. This modification makes pressure loss, ΔP_{BP}, directly proportional to the number of rows of tubes in cross flow. Once more, attention is directed to Step 13 in the example in which the 18 rows of tubes in cross flow appear in the numerical computation, although no N_c term appears in the analytical expression above the computation.

The correlation proposed is needed by industry, and Dr. Bell is to be congratulated for drawing this information together in a usable form. By developing analytical expressions for "f" and "j" in the various regimes of flow, we have adapted these computations to a digital computer and found the results extremely useful in quantatively evaluating the effects of the mechanical design parameters on pressure loss and heat transfer.

DR. R. M. CHRISTIANSEN
The Stearns-Roger Mfg. Company
Denver, Colo.

Referring specifically to Dr. Christiansen's remarks, I shall consider them in the order he mentions them . . .

1. The equation at the top of page C-29 denoted as "2" should have been designated Equation 2. Preferably, it should have been written

$$\ldots = \exp\left\{-\alpha F_{BP}\left[1-\sqrt[3]{\frac{2N_s}{N_c}}\right]\right\}$$

   This notation reduces the possibility of positioning errors such as occurred here.
2. The ordinate of Fig. 8b should be $(1-\Delta P_L/\Delta P_{NL_o})$.
3. I agree with Dr. Christiansen's argument on χ. I arbitrarily decided not to beat too heavily on a rather fragile concept in the descriptive discussion, but rely upon a detailed illustrative example to develop my point.
4. The omission of N_c from the denominator of the equation for "f" in Step 13 page C-40 is erroneous. For the example $N_c = 18$, and this number appears in the next equation properly. The equation for "f" in the nomenclature is correct.

I certainly thank Dr. Christiansen for his interest, his detailed examination of the paper, and for calling attention to the above errors.

DR. KENNETH J. BELL
Case Institute of Technology
Cleveland, Ohio

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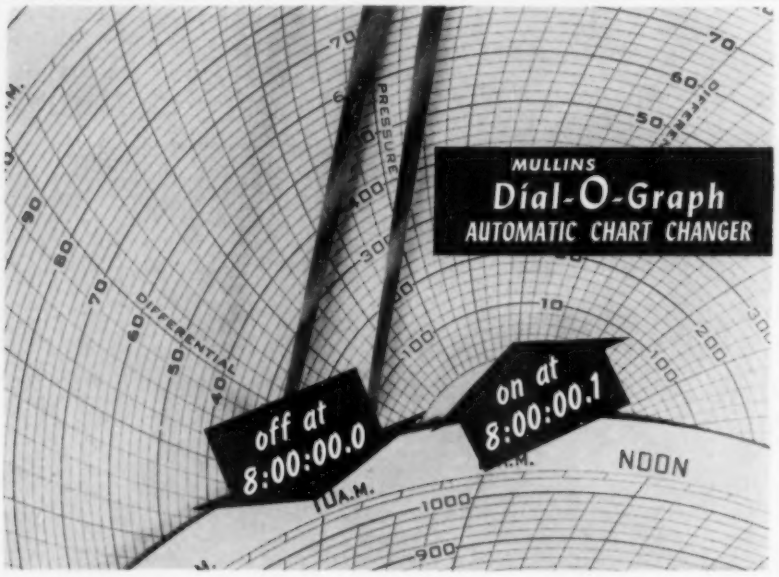

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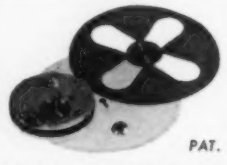

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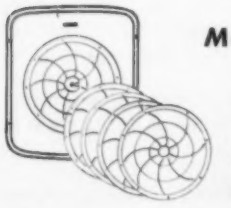

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Atomizing nozzles . . . Fig. 661 hollow-cone and Fig. 661-S solid-cone . . . are explained in Bulletin 6A Fig. 661, which gives capacity curves for each type as well as specifications and applications. *Schutte and Koerting Co.*

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Coupling specification booklet . . . pictures and describes Ever-Tite line of quick couplings. *Ever-Tite Coupling Co.*

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Cryogenic storage vessels . . . are subject of new Bulletin G-50 that deals with storage methods of liquefied petroleum gases at extremely low temperatures. Describes design of double-wall storage vessels, insulation systems, materials of construction, and accessories. *Chicago Bridge & Iron Company.*

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Density . . . is defined for benefit of users of the Model 930 air comparison pycnometer in Application Data Sheet P-8072. *Beckman Instruments, Inc.*

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Design Economics of Heat Exchangers Furnish Basis for Heat Transfer Cost Engineering

The application of cost engineering practices in the accurate evaluation of capital equipment in the process industries is rapidly becoming more and more vital to the management of process companies, as margins of profit grow narrower.

Management now depends increasingly, therefore, on modern cost-engineering practices to evaluate realistically the true, long-range economy of a given piece of equipment in relation to its initial cost, cost of installation, maintenance, operation, labor, replacement — and in relation to the productivity or profit of the process involved.

The importance of efficient, practical, long-range forecasting is increasingly a focal point in the process industries as a whole, but no where is it more important than in the purchase and operation of heat exchangers for use in continuous flow processes, where the operation of the unit never ceases, and therefore must be calculated on a basis of maximum longevity, efficiency and service. Included in the design of each heat exchanger must be a consideration of its initial cost, its cost of installation (including piping, fittings, valves, flanges, etc.), its operation and maintenance (including corrosion-protection, mechanical maintenance, cleaning, re-tubing, replacement parts) — and the factor of labor costs attendant to the installation, operation, maintenance and/or replacement of the unit.

In each case, however, the basic factors must be considered and determined: capital, overhead, maintenance and unit process costs.

The Cost Engineer, therefore, must be committed to continual study, re-examination and revaluation of every area which contributes to the practice of chemical engineering, for it is from his fundamental and technical knowledge of the process involved that his eventual forecasts for productivity, efficiency and longevity must ultimately spring.

Considerable thought has been given to the "ideal" background or qualifications for the Cost Engineer. Certainly his primary requisite must be a thorough knowledge of chemical engineering, including, in the heat transfer field, an equally intimate grasp of the thermal and metallurgical engineering so vital to an understanding of heat exchanger design economics.

Secondly, he should have had practical experience in the production phases of the chemical business. Thirdly, he will be better equipped to understand the complexities of the "business" side of such evaluations, if he has had education and/or experience in a certain amount of business administration.

Clear, concise, understandable communications is another factor of great importance to the ultimate success of the Cost Engineer, for he must transmit his findings, make his recommendations and defend his decisions to a number of widely varied types of people, some with technical background and others with little or no technical knowledge.

The Cost Engineer must be tireless on detail, inquisitive at each point, yet tactful in his demands on subordinates and associates. Above all, although cost engineering presents a real challenge to his analytical mind, he must serve his purpose with genuine humility, cognizant of the amount he has yet to learn.

In short, he should have a proclivity towards the functions of management, for that is where he might very well be headed.

FOOTNOTE: For more detailed information on this subject, write for your free copy of Booklet E-3, "Cost Engineering," to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. BOX 1888, TULSA, OKLA. — and for assistance on heat transfer cost engineering, please suggest our services — whether or not there's a heat exchanger in your company's future!

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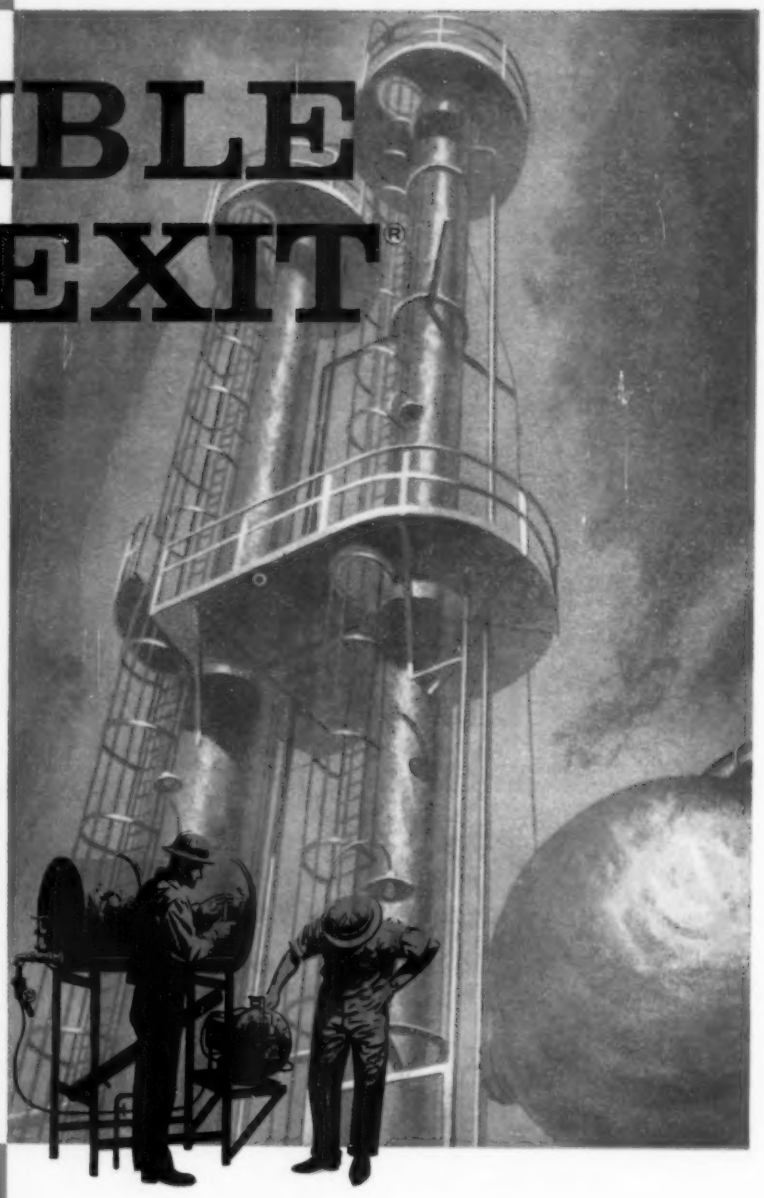

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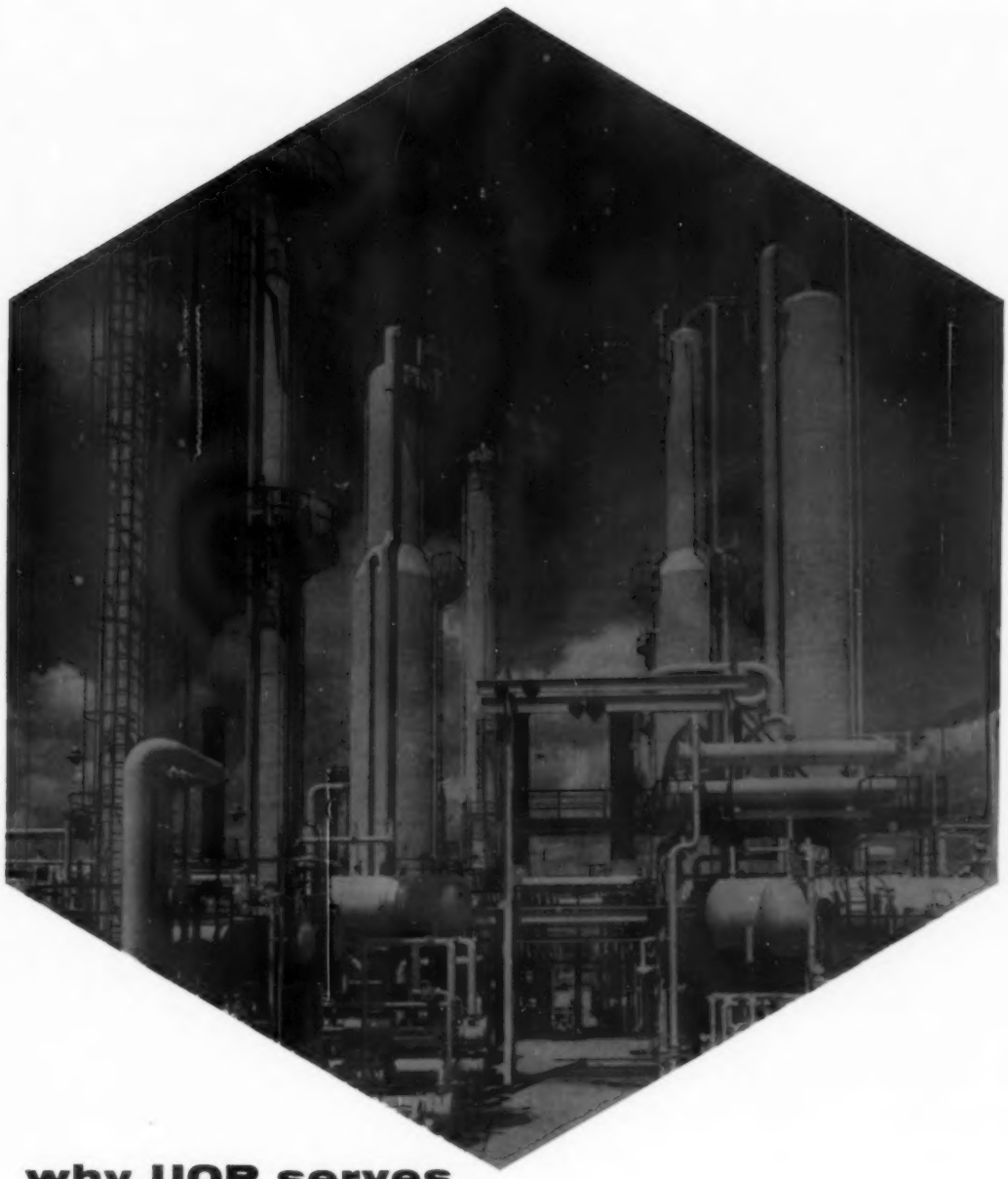

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Fluoroflex (Teflon) spargers . . . for injecting steam and other vapors below the liquid level . . . are manufactured in pipe sizes from 1 to 3 in. and any length up to 10 ft. Special curved spargers also available to meet specific process requirements. *Resistoflex Corp.*

Circle number (59) on reply card.

Gas odorants and their application . . . are detailed in 24-page technical bulletin containing as "the most comprehensive information ever compiled on odorants." *Oronite Division, California Chemical Company.*

Circle number (60) on reply card.

Gas service turbine flowmeter . . . that transduces gas velocity to a millivolt signal, the frequency of which is proportional to flow rate . . . is described in Specification Bulletin 10C1505-2. Unit's output signal can be fed into standard F&P digital totalizers and indicators; or by means of a frequency to d-c converter, the signal can be fed to any potentiometric receiver. *Fischer & Porter Co.*

Circle number (61) on reply card.

High-speed gas chromatographic system . . . the Model 284-B process vapor fractometer . . . is designed for use on multicomponent process streams. Applications include monitoring and closed-loop control of distillation tower fractionators, alkylation reactors, hydrogen sulfide to sulfur dioxide ratio in sulfur recovery plants, and oxygen and carbon monoxide in regenerators of catalytic cracking plants. *Perkin-Elmer Corp.*

Circle number (62) on reply card.

Hydrogen production and purification processes . . . are described in attractively illustrated 36-page booklet. *Girdler Construction Division, Chemetron Corporation.*

Circle number (63) on reply card.

Hypresphere lubricated plug valves . . . are now available in 12, 34, and 36-in. sizes. Compact, quarter-turn valves specially designed for line conditions requiring a full-opening, round bore valve. Hypraspheres are also produced in 16, 20, 24, and 30-in. sizes. *Rockwell Manufacturing Co.*

Circle number (64) on reply card.

New specifications . . . approximately double the capability of the Honeywell 400 computer. Internal speed is now reported to be about 10,000 three-address operations per sec, or the equivalent of 20,000 one-address operations per sec. A new off-line printing configuration is available, on an optional basis, for use as additional equipment. *Minneapolis-Honeywell Regulator Co.*

Circle number (65) on reply card.

Oscilloscope cameras . . . featuring binocular viewing, Polaroid film backs, a choice of three lenses, and a wide variety of accessories . . . are detailed in new specification sheet. *Analab Instrument Corp.*

Circle number (66) on reply card.

Panel-type air filters . . . are detailed in Bulletin A-1, which gives characteristics of Dynel, new filter fiber whose method of formation results in a low density three-dimensional batt permitting the elimination of face supports and facilitating depth loading. *Union Carbide Development Co.*

Circle number (67) on reply card.

Petrochemical industry applications . . . of the Vibraswitch malfunction detector are explained in Special Report V-103, which cites six specific instances in which these units protected various pieces of equipment and prevented extended down time and/or serious damage. *Robertshaw-Fulton Controls Company.*

Circle number (68) on reply card.

"Poncho" . . . new preformed insulation for standard pipe fittings . . . is manufactured from extra fine glass fibre wool and is bonded and molded to accurately conform to the exact configuration of the pipe fitting. Fast, easy application results in great labor savings. Catalog available. *Houston Reinforced Plastics Co.*

Circle number (69) on reply card.

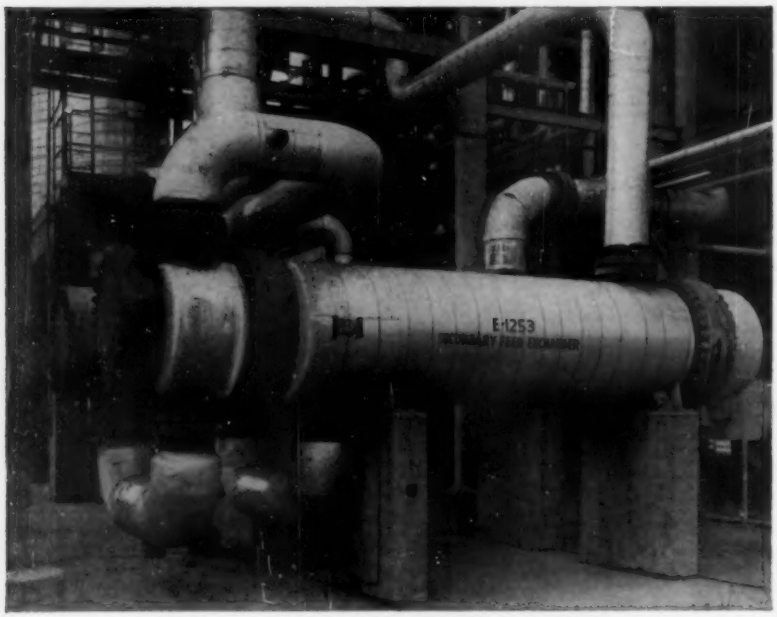
Poppet type air control valves . . . are covered in new digest catalog, Bulletin 60-2, planned for quick easy reference. *Hoffman Valves, Inc.*

Circle number (70) on reply card.

Portable crude distillation unit . . . designed to process 200 bbl of crude per day (35 gravity of higher) into gasoline, diesel fuel, and residual fuel oil . . . is explained in new bulletin. *Williams Brothers.*

Circle number (71) on reply card.

Pretreatment for effective corrosion control . . . is subject of new water condi-



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tioning data sheet that tells how rapid film formation by pretreatment can vastly improve cooling water corrosion control. *Betz Laboratories, Inc.*

Circle number (72) on reply card.

Process control instruments . . . including Microsen closed-loop, all-electronic process control systems; capacitance actuated level detection and control instruments, and vibraswitch malfunction detectors . . . are covered in Bulletin 10, which describes functions and applications for individual instruments and groups of instruments. *Robertshaw-Fulton Controls Company.*

Circle number (73) on reply card.

Process equipment and systems . . . for size reduction, size classification, mixing and blanding; materials handling systems, pelleting and densifying equipment, and general process equipment . . . are cataloged in Bulletin 200-B. *Sprout-Walden.*

Circle number (74) on reply card.

Profits down the drain . . . from stuffing box leakage are discussed in new brochure that tells how this problem can be overcome. Gives data on metering units with leak-proof design. *Lapp Insulator Co.*

Circle number (75) on reply card.

Refractories for HPI applications . . . are subject of data sheet that contains tables on castable refractories, illustrations of a typical refractory anchor arrangement for catalytic cracking units, and information on acid-proof brick, shapes, and floor tile. *Harbison-Walker Refractories Co.*

Circle number (76) on reply card.

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Regulators . . . Model 1001 . . . which provide accurate control of gas for installations both large and small flow rates, and where supply pressures ranging up to 200 psi must be reduced to 60 psi or less, are described in Bulletin 1059-Rev. 4. *Rockwell Manufacturing Co.*

Circle number (77) on reply card.

Rotary positive displacement blowers . . . are described in a summary bulletin that gives details of manufacturers entire line. Information includes speed and pressure ratings, gear diameters, overall unit sizes, details of special features, and direction for connecting to power sources. *Sutorbilt Corp.*

Circle number (78) on reply card.

Rubber products . . . including Poly-V drive, V-belts, transmission belt, conveyor belt and all types of hose; flexible rubber pipe and expansion joints, and molded and extruded products . . . are detailed in newly revised 24-page general catalog. *Manhattan Rubber Division, Raybestos-Manhattan, Inc.*

Circle number (79) on reply card.

Rust . . . how to remove or prevent it safely and economically . . . is subject of Service Bulletin 16B. *Oakite Products, Inc.*

Circle number (80) on reply card.

Seamless welding fittings and flanges . . . in carbon, alloy, and stainless steels . . . are detailed in Bulletin FB-502A. Contains charts of standard sizes and schedules according to ASA B36.10 and ASA B36.19; comprehensive breakdown of dimensional tolerances; chart of sizes and types available. *Babcock & Wilcox.*

Circle number (94) on reply card.

Sight-glasses . . . that virtually eliminate possibility of ruptures and blow-outs and their accompanying fires and explosions . . . are explained in brochure "See With Safety Under Pressure." *PresSure Products Co.*

Circle number (95) on reply card.

Single shaft gas turbine . . . new Model 305-S . . . is presented in Bulletin 186, which gives features of this 9000 hp unit. Contains cutaway cross section, complete dimensions, and specifications. *Clark Bros.*

Circle number (96) on reply card.

Six-Pack . . . a fixed program analog computer building block designed to be incorporated as original equipment for machine tool and process instrumentation and simulation . . . is explained in new specification sheet. Unit accommodates six pairs of plug-in amplifiers (of a variety of types) to provide six channels of high gain, drift-stabilized analog computation. *Embree Electronics Corp.*

Circle number (97) on reply card.

Sliding gate control valves . . . recommended for use on steam, water, air, oil, gas, and chemicals . . . are detailed in 8-page Catalog J170-1. *OPW-Jordan Corp.*

Circle number (98) on reply card.

Snap-in ferrule . . . is featured in latest Intru-lok tube fitting. The dimpled ferrule is retained by the nut. It can be pushed in or out with the fingers, but otherwise it won't drop out to become lost. *Parker-Hannifin Corp.*

Circle number (99) on reply card.

Solenoid-operated shut-off valve . . . has no organic parts. Also features lightweight construction, straight-through flow with little pressure drop, and low electrical power requirements. Rugged unitized body of aluminum and stainless steel integrates the line connection, chamber, seats, and plunger sleeve. *Polymet Co.*

Circle number (100) on reply card.

Storage water heaters . . . new NiaWel line . . . are covered in Bulletin 61, which contains complete specifications for 55 sizes in both vertical and horizontal models plus 114 sizes of removable U-tube heating elements. *Niagara Weldments, Inc.*

Circle number (101) on reply card.

Tank truck meter for the petroleum industry . . . the Rockwell T-120 . . . has capacity of 120 gal per min. Can be installed on new or existing piping arrangements. *Rockwell Manufacturing Co.*

Circle number (102) on reply card.

Telemetering equipment and systems bulletin . . . gives basics of transmitter and receiver operation in a time-duration impulse system, describes and pictures Chronoflow transmitters and receivers, and lists applications. Reference No. 230.20-2. *B-I-F Industries.*

Circle number (103) on reply card.

2 New Developments to Modernize Your Liquid Handling Operation

Flight Refueling engineers were asked to apply their extensive aerial refueling systems background to current needs of the commercial fluid handling industries. Here are the results!

"dripless dripstick"

Accurately measures the liquid contents of any container—fast and safely. Mounted top or bottom, this indicator remains hermetically sealed. Just read the extended calibrated rod as it "pops" out of the sealed container.

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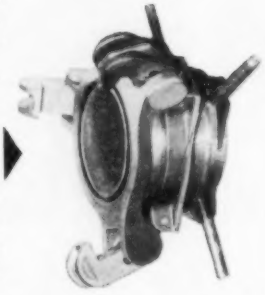

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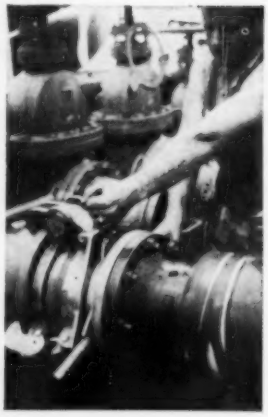

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It can get pretty lonely around 2 a.m. The cleaners and charwomen have gone home. There's only one light on in the whole building.

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If you have an emergency catalyst problem or want facts about catalysts . . . dial "S" the 24-hour service phone number (SAratoga 7-3912, Baltimore, Maryland.)

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Top entry 150 psi Flo-Ball valve . . . is hailed as only ball valve with external provision for seat adjustment by simply tightening two hex nuts on the bonnet. Removal of the bonnet flange permits easy access to the ball and seats. Has Teflon seats and seals. Manufactured of carbon steel or 316 stainless steel in 1, 1½, 2, 3, 4, 6, and 8-in. diameters. *Hydromatics, Inc.*

Circle number (104) on reply card.

Tube fitting catalog . . . tells about company's "O-Ring Seal" line and accessories. Contains cut-away illustrations, specification tables, typical applications. *The Lenz Company.*

Circle number (105) on reply card.

Tubing brochure T-459 . . . gives facts about electric-resistance-welded carbon steel mechanical tubing, Lectrosonic cylinder tubing, and Lectrosonic JIC hydraulic line tubing. *Babcock & Wilcox.*

Circle number (106) on reply card.

Underground pipe wraps for corrosion control . . .are detailed in new catalog. Technical tables are included as a guide to the proper thicknesses, widths, laps, and other information necessary for specific jobs. *Owens-Corning Fiberglas Corp.*

Circle number (107) on reply card.

Valve Bulletin No. 7 . . . catalogues Aloyco line of corrosion-resistant valves. Has cross-section illustrations of valves and adaptable features, with specifications for each. Lists alloy materials, chemical composition ranges, and minimum mechanical properties, *Alloy Steel Products Co.*

Circle number (108) on reply card.

Valve sizing . . . is simplified with the aid of charts in Bulletin JSC-1. Technical data applying to all makes of valves tells how to adjust sizing for variations in pressure, temperature, viscosity, or specific gravity. Charts cover steam, liquid, and gas service. Cross-reference method of compiling makes sizing easy by eliminating need for rulers, formulas, or slide rule. *OPW-Jordan Corp.*

Circle number (109) on reply card.

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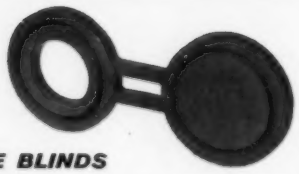
All welded, carbon steel cone, flat, or basket types. Heavy gauge ring with tab for raised face or ring joint flanges. Also in stainless steel or special alloys.



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Spectacles, spades or spacers, machined to code specifications. For raised, flat face, or ring joint flanges.

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Now... security against even momentary outages during power-disrupting storms. Collins' dc-powered Microwave and Carrier Systems operate directly from float-charged batteries — eliminating rotating machinery. The results: improved reliability, reduced power drain, lower maintenance, decreased noise and elimination of standby generators. Several voltage combinations are available, enabling you to select the one that best integrates with your existing plant. For technical literature, write Collins Radio Company, Texas Division Sales, 1930 Hi-Line Drive, Dallas 7, Texas.

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Here's why a GROVE G-5 never needs maintenance

The big reason you can hook up a Grove G-5 and forget it is the famed Grove full opening "big valve" design. You get (1) precision ground, chrome plated and polished side plates for positive metal to metal seal, backed by (2) proven Grove protected Seal-O-Rings on both sides of the gate, for (3) up and down stream seal. Because the Seal-O-Rings are on the gate (4), they are out of the flow at all times, protected from damage caused by contaminates in the bore. The big plus feature — Grove G-5 valves never need lubrication. Grove series 150 G-5 valves are available in lever or handwheel operated models, sizes 2" through 36".

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SHAPING THE FUTURE . . . *in Pipelining*

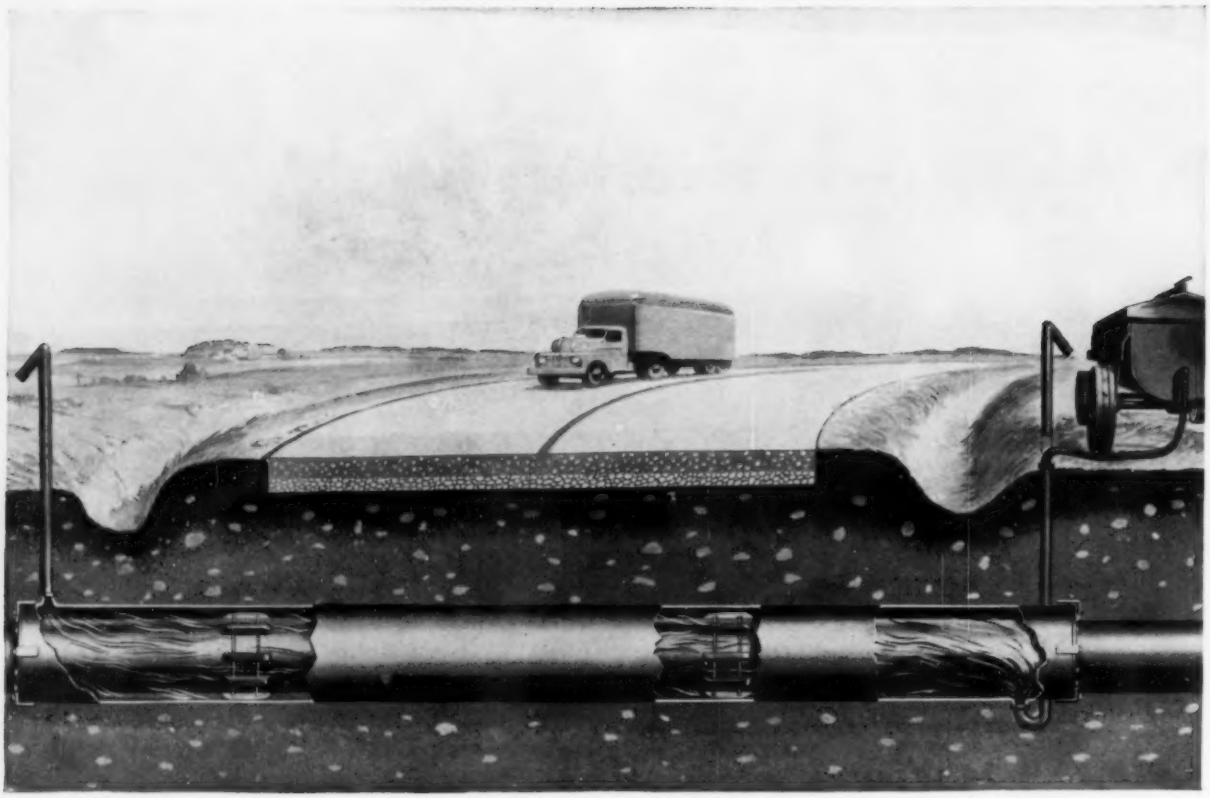
THE PIPELINE INDUSTRY WILL LEAN EVEN MORE HEAVILY ON TELEMETERING in the future. Already the operation of pipeline systems has been "completely changed" by its use, says I. B. Cloessner, Jr., of Humble Pipe Line Company speaking before the American Institute of Electrical Engineers. But, although adequate in many respects, more accuracy and dependability are needed because of new demands that will be made on telemetering equipment, he asserts.

COMPLETE CONTROL OF THE END USE OF GAS may be a step closer to reality as a result of the U.S. Supreme Court's decision in the Transcontinental-Consolidated Edison case. In ruling that FPC was within its powers in denying Transco a certificate to transport gas for Consolidated Edison Company for use as fuel in its electric generating plants, the high court said "the commission has the power to consider 'end use' and price factors." Also, "one way to prevent waste is to limit the uses to which it (gas) may be put for which another, more abundant fuel, may serve equally well."

PIPELINE CONTRACTORS DID 20% MORE WORK LAST YEAR FOR 20% LESS MONEY, retiring president Jack S. Gray told members of the Pipe Line Contractors Association at their annual meeting. But, instead of this meaning that they were 40% more efficient, it really meant they were caught in the middle of a severe cost-price squeeze, he said. Increasing emphasis on short loop lines, which necessitates a more careful bidding of jobs, the general economic downtrend, and FPC inaction were pointed out as the principal factors contributing to the contractors woes.

AMMONIUM NITRATE, SOMETIMES REFERRED TO AS FERTILIZER, has been used to a limited extent by the pipeline industry as a blasting agent. It has two disadvantages, however: (1) Relatively expensive boosters are required to detonate it, and (2) ammonium nitrate tends to dissolve in water-filled drill holes. Midwest Research Institute at Kansas City now has a project underway to overcome these disadvantages.

A NEW STEEL DEVELOPED BY U. S. STEEL CORPORATION may give impetus to the shipment via tankers of liquefied gas. Liquefied gas could be carried in vessels made from the 9% nickel alloy steel at temperatures as low as minus 320 F, it is said. Many foreign fields, especially, are now forced to flare gas produced with oil, or keep gas wells shut in, because there is no market.



End costly road heave with CM casing filler

NO-OX-ID® CM casing filler gives complete and dependable control of destructive frost-heave in gas lines under highway and railroad crossings.

This addition to Dearborn's time-proved line of chemically inhibited protective coatings virtually eliminates frosting conditions caused by low gas temperatures on the discharge side of regulator stations. This pressure-variance induced temperature drop occurs regardless of outside weather conditions and the consequent pipe heave from underside frost and icing can result in substantial pavement cracking and damage.

CM casing filler is introduced by pumping into the under-highway pipe casing required by most State Highway Commissions. It completely fills the annular space, displacing entrapped air and preventing water accumulation. CM filler solidifies to a soft jell without appreciable change in volume and retains this consistency through wide temperature ranges.

Send for detailed technical Bulletin No. 3079-A today.

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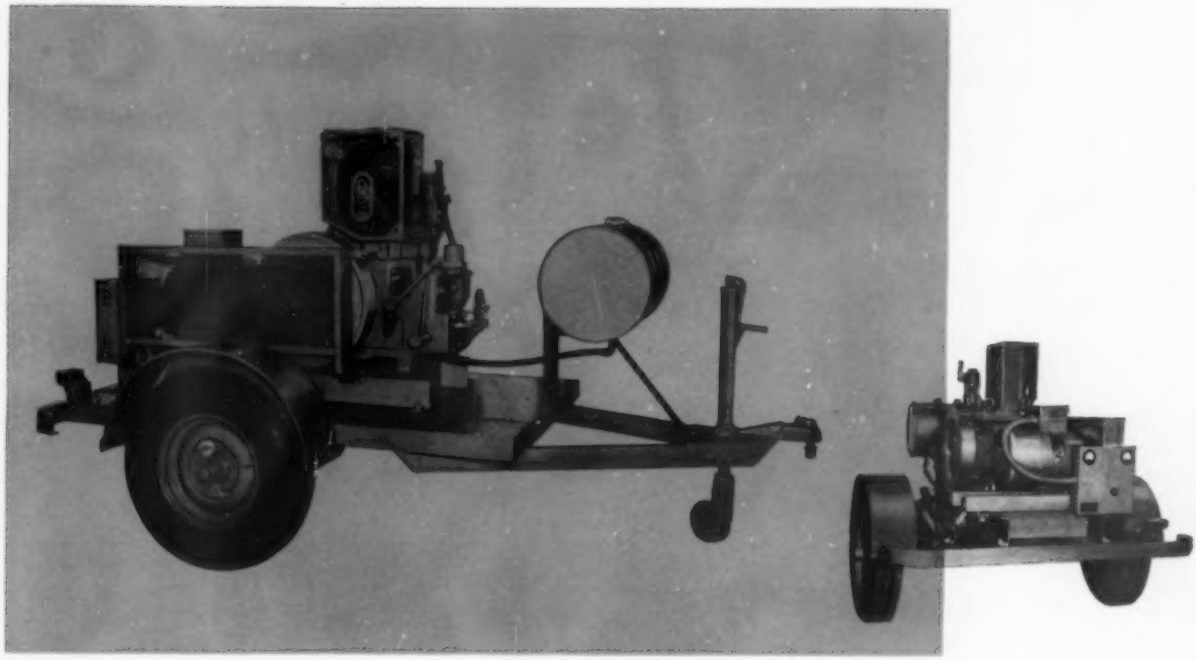

Witte's 98RBD trailer-mounted engine-generator unit has a standard 3 KW DC shunt-wound generator in a wide speed range from 750 to 1800 rpm.

Witte 98RBD Cathodic Protection Unit enables you to offer pipeline customers another profitable service!

Here is a heavy-duty, highly mobile, cathodic protection unit that will enable a pipeline contractor to provide an added service to his customers. This engine-generator unit will afford him an opportunity of recommending and furnishing the necessary amount of protection when the pipeline is installed.

It is a known fact that a corroded pipeline cannot be restored, but corrosion loss can be stopped if cathodic protection steps are taken in the early stages of a pipeline installation.

Witte's 98RBD is built especially for this type of continuous operation. The heavy-duty oilfield-type gas engine has been thoroughly field-tested. It has a low center of gravity, is well-balanced, and every part is easily accessible. The engine has condenser cooling, removable wet cylinder liners, and roller main bearings. It is equipped for long-run service, having oil make-up reservoir and float valve as well as lube oil and cooling water safety controls.

These trailer-mounted units have a 32-40 volt, 3 KW generator in a wide speed range from 750 to 1800 rpm. They are V-belt driven, with a voltage control to less than 5 volts when the generator speed is 750 rpm.

Complete information on both the standard and trailer-mounted Witte gas engine-driven generator units is available through oilfield supply stores.

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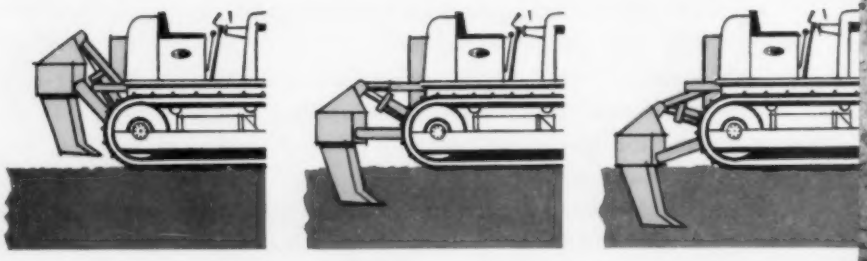
Offices and Plant: Kansas City 26, Missouri

The unique parallelogram design of Allis-Chalmers rippers keeps shanks at the most effective angle . . . up . . . halfway down . . . down full depth.



TOUGH TOOLS MATCH TOUGH JOB POWER

Allis-Chalmers rear-mounted rippers maintain most effective penetration angle at all depths . . . up front, specially designed bulldozers make most of HD-21's tremendous power.

Modern tractor power, *plus* modern ripper and dozer design, is making a big difference on today's tough jobs. With the HD-21 and ripper, for instance, up to 60,000 pounds of drawbar pull let you rip 'n' doze what you once shot and shoveled . . . puts one man, one modern machine in place of a typical 4-man blasting operation.

Allis-Chalmers leads the field in making rippers practical and effective for these tough jobs. The introduction of *parallelogram design* — unique Allis-Chalmers feature on these big HD-21 rippers — keeps shanks at most effective penetration angle *at all depths.* You get the *same* effective tooth angle *. . . up . . . halfway down . . . or working a full two feet deep!*

In addition, Allis-Chalmers dozer design utilizes the latest developments in steel to produce durability which makes the most of today's big tractor power without profit-killing maintenance and repair. Trunnions, "C" frames, struts and moldboards match the HD-21's brute strength. If you're bidding or working *any* tough materials, your Allis-Chalmers dealer will furnish all the facts on successful ripper/dozer application. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

Now available in Persian Orange or Allis-Chalmers Yellow at no extra cost.

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ALLIS-CHALMERS

power for a growing world

NEW BARBER-GREENE 777 WORLD'S LARGEST, FASTEST FULL-CRAWLER WHEEL DITCHER

The new Barber-Greene Model 777 is the world's largest, fastest, and most powerful full-crawler pipeline ditcher. The Model 777 digs up to 40% faster, weighs 37% more, has 40% more power and digs one foot deeper, than any other full-crawler pipeline wheel ditcher. The machine weighs 57,000 lb., is powered by a 135 hp diesel engine, and digs 8′ 6″ deep and 54″ wide trench. Top trench width may be increased to 10′ or more through use of slopers.

The 777 has the digging capacity, weight and power of half-track ditchers with maneuverability never before available on any full crawler ditcher. The 777's dual-range "Hydra-Crowd"—independent full-hydraulic drive to each track, puts an infinite number of crowding speeds from zero to 66 fpm at the operator's fingertips. Time consuming clutching, shifting and braking while digging are eliminated. Since one track may be driving forward while the other is in reverse, the machine turns within its own length without stress buildup from locked tracks, walks through heavy footing and quickly positions for crossings or set-ins.

All machine operating functions such as crowding, transmission wheel speeds and wheel hoist are completely independent of each other. Spoil conveyor is hydraulically driven, and belt speeds are again infinitely variable up to 1,000 fpm. Digging wheel is mechanically driven by short, completely housed drive chains, and split drive shaft. Three-point track suspension and a split drawbar are other production-boosting features.

Write for new 777 Bulletin, specifications and comparisons.

"Our Model 777 outdigs competitive ditcher by over 30%," says Vice President Dick Cagney, Contracting & Material Co.

Contracting & Material Co., Evanston, Ill., dug approximately 70 miles 24, 26 and 30″ pipeline trench with a Barber-Greene 777 during 1960 and Vice President Dick Cagney says: "Working on the same jobs with a competitive ditcher, the new 777 gave us 30% more ditch per day. We averaged 6,000′ in 10 hours when trenching 46″ wide, 6½′ deep and sloping to 8½′ with peak production hitting 7,000′. I don't see why everyone doesn't have a 777 because of its high productivity and low maintenance."

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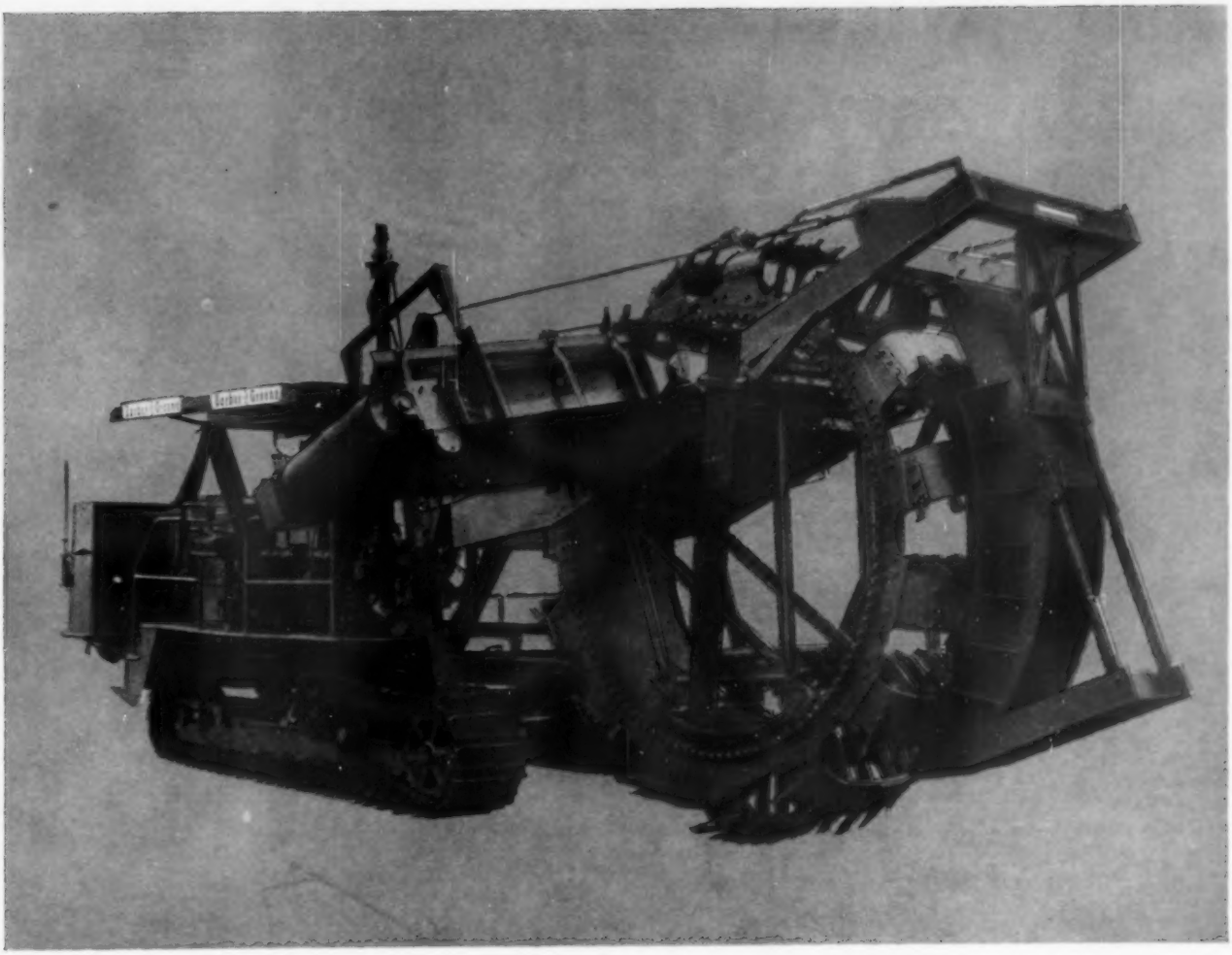

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D	2" x 60"	2.6	46	Ground Bed
E	3" x 60"	4.0	115	Salt Water
G	2" x 9"	0.4	5	Ducts
J	3" x 36"	2.5	80	Salt Water
M	2" x 60"	2.8	57	Salt Water

*Applicable also in fresh water service. Should not be used in ground beds without backfill.

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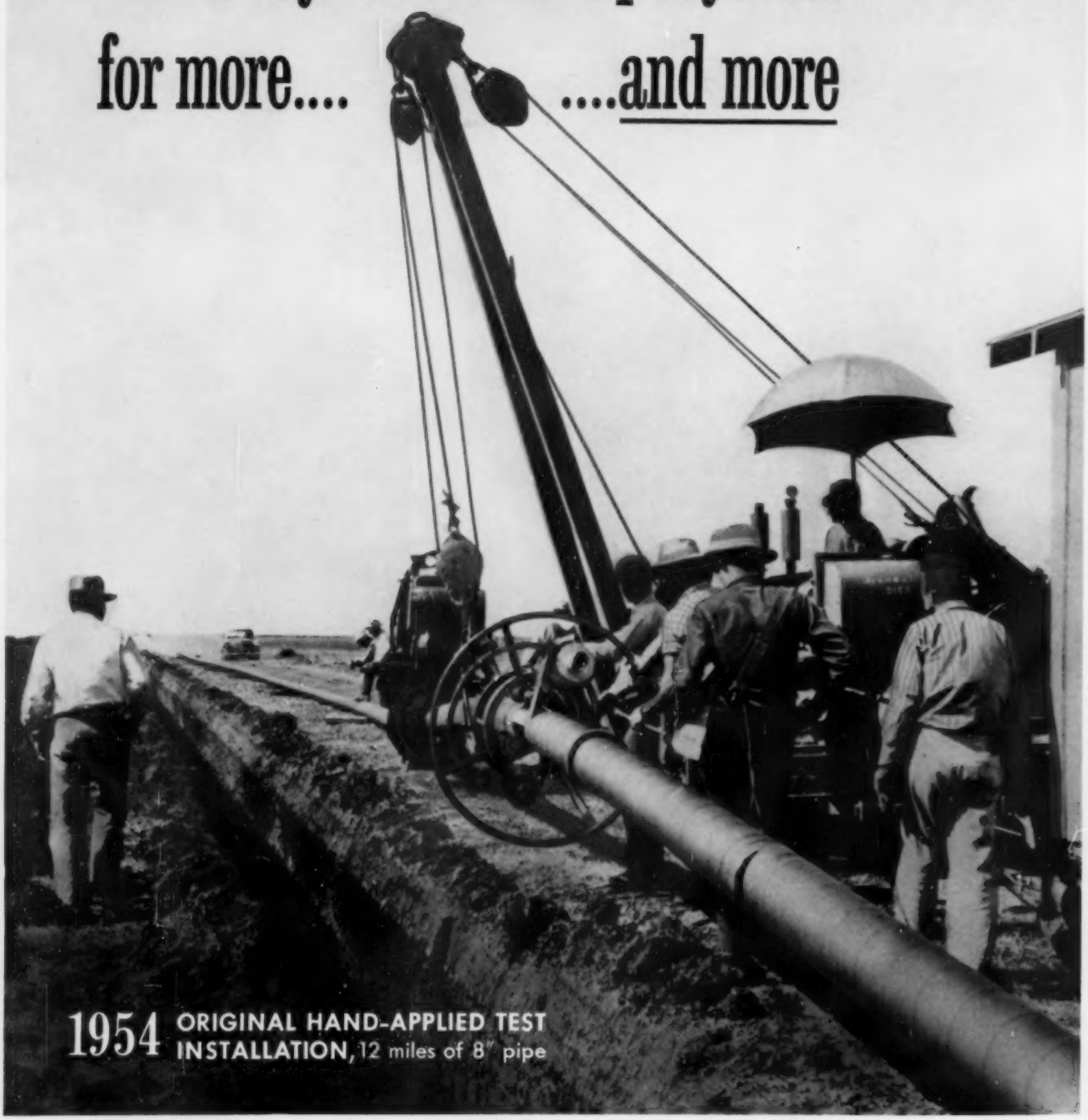

1954 ORIGINAL HAND-APPLIED TEST INSTALLATION, 12 miles of 8" pipe

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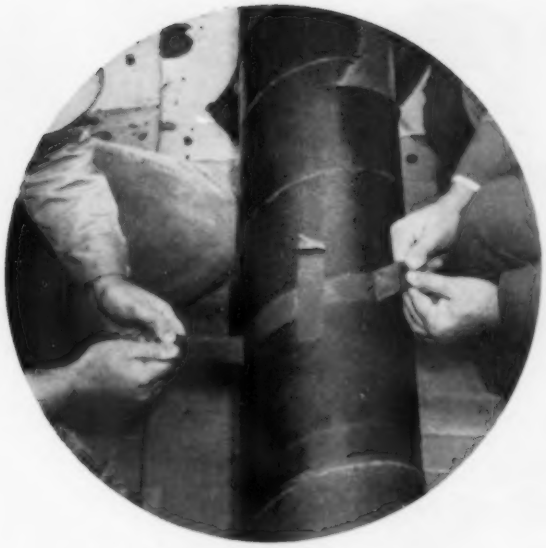

Bell hole examination convinces second firm, too, to make important use of Polyken protection!

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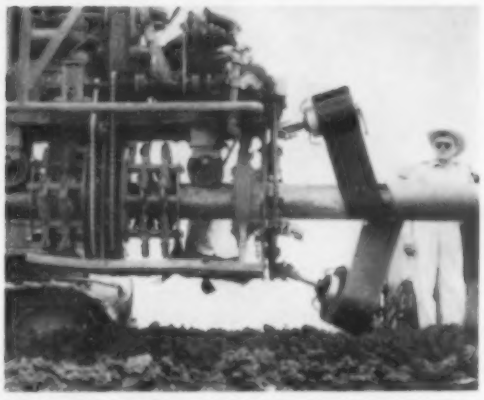
1957 ANOTHER SEADRIFT INSTALLATION, 31 miles of 6″ pipe



1960 STILL ANOTHER SEADRIFT INSTALLATION, more than 300 miles of 6″ and 8″ pipe

1960 ANOTHER MAJOR PRODUCTS PIPELINE INSTALLATION, on 8″ pipe

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Experienced in modern PROTECTIVE COATINGS

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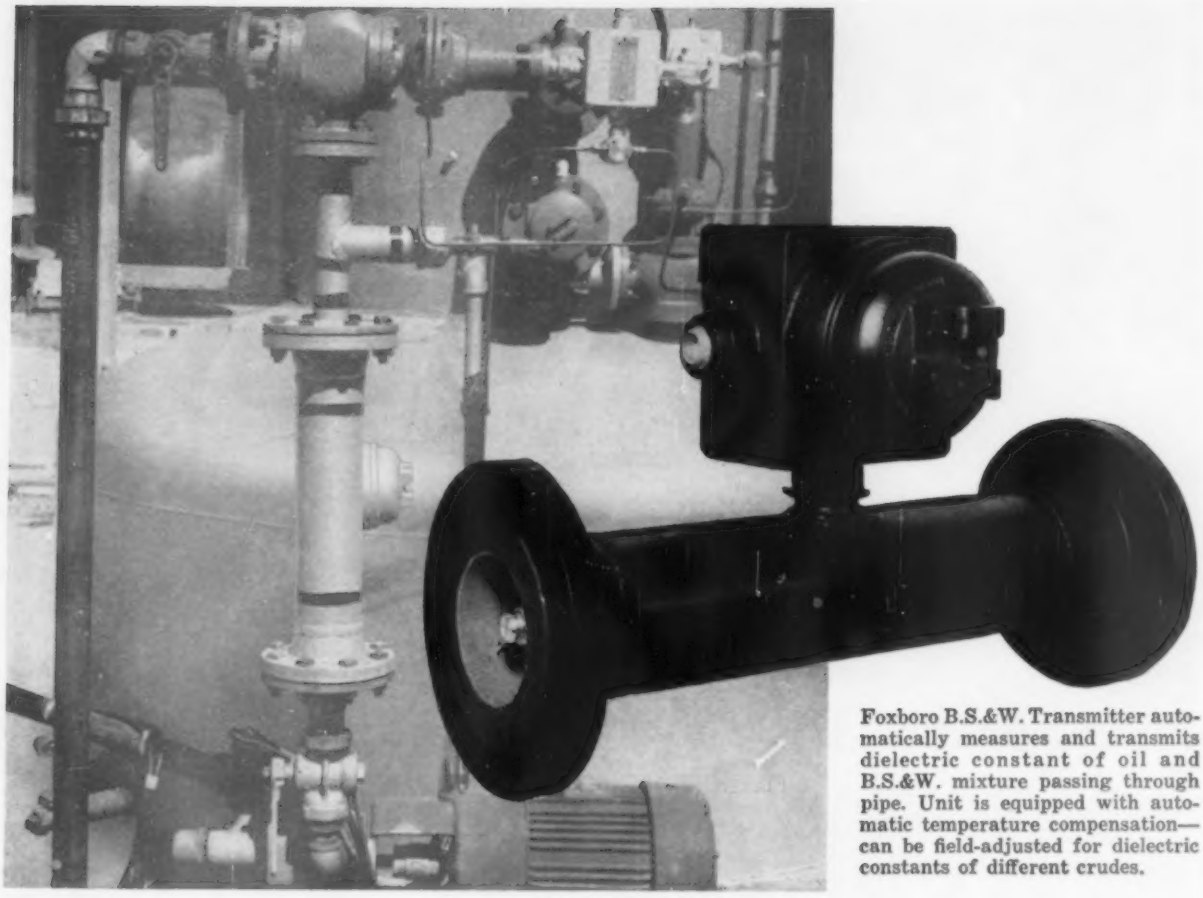

Foxboro B.S.&W. Transmitter automatically measures and transmits dielectric constant of oil and B.S.&W. mixture passing through pipe. Unit is equipped with automatic temperature compensation—can be field-adjusted for dielectric constants of different crudes.

unique Foxboro system gives continuous, unattended measurement of B. S. & W.

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Here's how. A Foxboro measuring element, installed in the pipeline, continuously measures B.S.&W. content of the crude, in terms of dielectric constant. Changes in dielectric are then transmitted electrically to a Foxboro capacity Dynalog* Recorder.

And that's it. Remedial action can be incorporated by having the Dynalog Recorder equipped with an electric contact for sounding an alarm or operating diversion valves to re-route off-spec oil.

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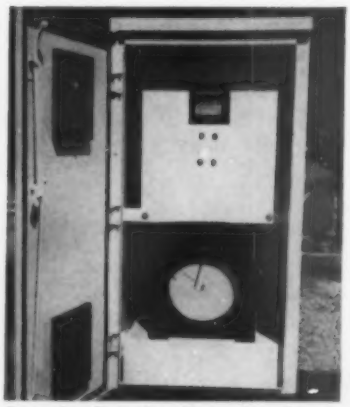

Capacity Dynalog Recorder (lower instrument) receives measurement from B.S.&W. Transmitter, records it, and initiates alarms or re-routing of oil flow.

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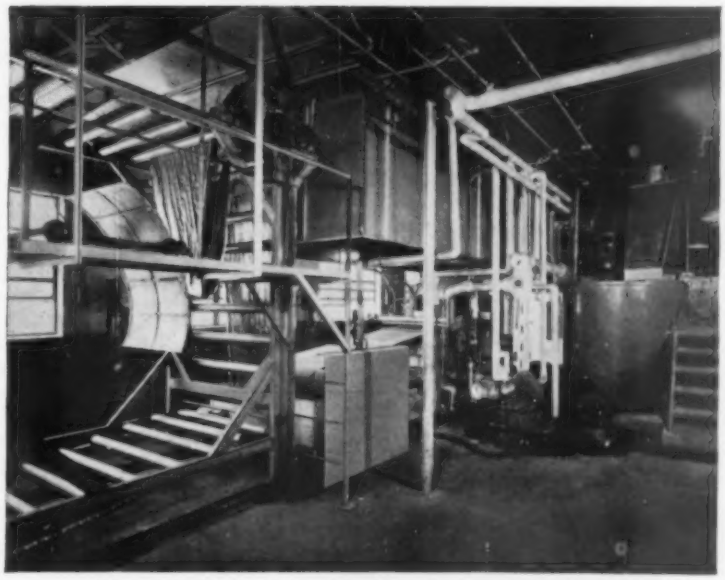

View of specially-designed machine developed after five years of research by Tapecoat engineers to convert raw materials automatically into TAPECOAT 20.

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MARSHALL E. PARKER, *Consulting Corrosion Engineer, Houston, Texas*

THE ELECTRICAL CONDUCTANCE of pipe coating is a very useful quantity in the evaluation of its effectiveness. Alone, it is strongly indicative of coating quality, and is almost completely proportional to the amount of current required to maintain a line under cathodic protection.

It fails to be directly indicative of coating quality because it is also influenced by soil resistivity; what is actually measured is not coating conductance alone, but *leakage conductance to remote earth.* This quantity can be measured for a bare line just as easily, and in fact by the same methods, as are used for coated lines.

In the case of a bare line in *uniform* soil, the value obtained will be directly proportional to the conductivity of the soil (assuming uniformity in pipe surface conditions). In the case of a bare line in non-uniform soil, the value obtained will be directly proportional to the *average* conductivity of the soil — provided the right kind of average is taken. Just what this average should be is not easy to prescribe, but it appears to be approximately that which would be obtained by a Wenner (four-point) measurement, using a pin spacing about one and one-half times pipe depth. If the soil also varies along the line, as well as with depth, then a geometric or logarithmic average of a set of Wenner readings, equally spaced along the line, is indicated.

In the case of a coated line, the influence of soil resistivity (or its reciprocal, conductivity) is less obvious. The total resistance of the path from the pipe to remote earth may be considered in two simple ways: (1) As the sum of the resistance through the coating, from pipe to soil, plus the resistance through the soil, from the outside of the coating to infinity; or, (2) as a parallel circuit through the coating, one path being direct coating conductance as above, the other being through soil moisture in the inevitable holidays; plus the soil path from coating surface to infinity, as above.

It appears far more logical to accept the second interpretation. If this is the true state of affairs, and if the coating itself be considered as a perfect insulator, then the measured total leakage conductance of a coated pipeline would also be found to be exactly proportional to the soil conductivity — again provided the correct average was chosen.

An effective pin spacing of much more than one and one-half times pipe depth is needed—but how much more would depend on the average size and spacing of the holidays, and cannot be stated with any precision. As the coating itself is not a perfect resistor, but has finite conductance, then the situation is still less clear. About all that can be said with assurance is that the measured value of total leakage conductance of coated pipe is partly dependent on soil resistivity, although not as much so as is the case with bare pipe; and the better the coating, the less effect soil resistivity appears to have. Part of the reason for this is that

a series of soil measurements taken at different locations with a large pin spacing will differ less than an equally numerous set taken with small spacing; part, of course, is due to the series effect of the coating as a conductor.

The quantity, *total leakage conductance to remote earth*, can be defined most accurately by a mathematical equation, a variation of Ohm's law:

$$K = dI/dE \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

K is the total conductance, and is expressed in mhos (one mho = 1 ampere per volt). I is the current, in amperes, drained from the pipe and discharged to remote earth; E is potential change with respect to remote earth caused by the drainage of the current, and will be expressed in volts.

Note that this is the total conductance of a piece of pipe, not the conductance per foot or per square foot. Also note that this equation is given in differential form; the conductance is the ratio of a very small current to a very small corresponding change in voltage; it is the initial slope of a curve showing how potential changes with current. As it is actually measured, the conductance is usually defined by the following expression:

$$K = \Delta I/\Delta E \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This differs from the first form only in that the changes in current and potential are now recognized to be of finite value. Whether this form is valid or not depends upon whether the actual conductance of real pipe is ohmic in nature or not; in other words, whether or not the curve of potential versus current is a straight line. Certainly, for very large values, this is not the case; however, for values of ΔE which lie within the range of values commonly used in cathodic protection, it is essentially true, if due care is taken to avoid polarization errors, as will be discussed later.

The usually reported quantity is the unit conductance, or conductance per unit length. Units may be mhos per foot, micromhos per foot, or mhos per megafoot. The last is a very convenient unit, since it leads to numbers of a convenient size, and will be used throughout this discussion. It can be obtained by dividing the total conductance by the length involved, or by using for ΔI the current per unit length; in some of the methods described later, it automatically will be the value obtained.

The definition of coating leakage conductance can now be given: *The coating leakage conductance of a section of pipeline to remote earth is the current per unit length that passes when unit potential exists between the pipe and remote earth.*

Remote earth is a necessary concept in the mathematical development of the subject, although it offers difficulties both in definition and in realization. What is meant is a degree of remoteness such that further increases in distance do not appreciably affect the readings. In practice, it is found that with the best coatings, an electrode position directly over the pipe is sufficiently remote, as the greater part of the potential drop occurs across the coating. Even for bare pipe, a distance of a few hundred feet usually is adequate, although the residual error is probably greater than in the case of good coating. One implication of this condition is that we are not able to measure the conductance of poor coating with as high a degree of precision as is possible with good coating; this, however, is a tolerable situation; precise values of the conductance of poor coating are not needed.

Another important electrical characteristic of pipe that is inextricably involved in any attempt to measure the conductance of sections of any length is the longitudinal resistance of the pipe itself. This quantity, designated by the symbol r, is given in ohms per unit length; for consistency, in the present discussion, ohms per megafoot will be used. This quantity may be approximated from the pipe weight, using the expression:

$$r = 252/W \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where r is the longitudinal resistance in ohms per megafoot, and W = the pipe weight in lb per ft.

There is considerable variation among several steels, however, and a fairly large tolerance in weight; so, for accuracy, the resistance of the pipe under study should be determined by direct field measurement, as will be described later.

The importance of this quantity lies in the fact that the electrical behavior of any appreciable length of pipe necessarily must involve the resistance of the pipe itself. If current is drained from a single point, for example, then the conditions at some distance from that point depend not only on the conductance between the pipe and the earth, but also on the resistance of the line between the drain point and the point in question. One effect which this has is that if a pipe is sufficiently long, then its behavior at the drain point becomes independent of conditions beyond a certain distance. The line can be terminated, grounded, connected to larger lines, or anything at all; no effect will be felt at the drain point.

Attenuation

When current is drained from a single point on a long pipeline and discharged to remote earth, the potential of the line with respect to remote earth is shifted. This shift in potential is greatest at the drain point, and becomes smaller and smaller as the distance from this point increases. Similarly, the magnitude of the current flowing in the line is greatest at the drain point, for there it consists of all of the current picked up from the earth; at more and more remote points, the line current is smaller and smaller.

In order to treat this attenuation or diminution of effects mathematically, certain simplifying assumptions

COATING LEAKAGE CONDUCTANCE

guide in evaluating effectiveness of coatings — PART I

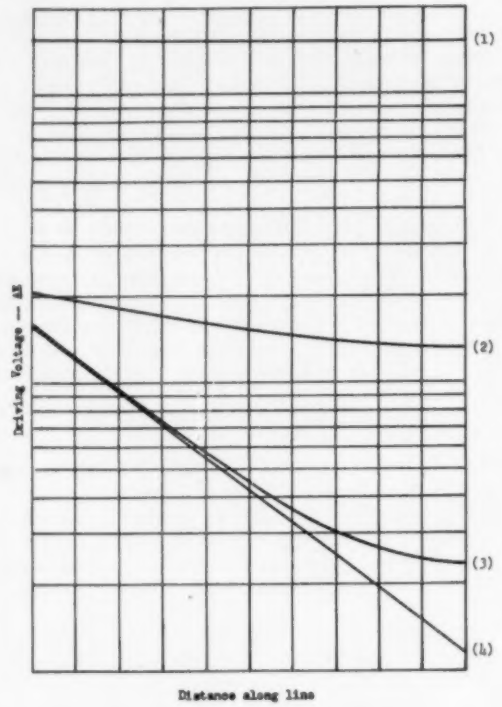

FIG. 1. Variation of shape of attenuation curve for lines of different electrical length.

(1) Very short line; $\alpha L = 0.1$ (3) Long line; $\alpha L = 2.6$
(2) Short line; $\alpha L = 1.0$ (4) Infinite line; $\alpha L = \infty$

must be made, as is common practice in developing a mathematical model of a physical system. It is necessary to remember, in using the results, the nature and extent of these assumptions, and to realize the limitations they place upon the area of validity of the derived expressions.

Consider a long uniform conductor (representing the pipeline) having a uniform resistance of r ohms per megafoot. Let there be another long conductor lying parallel to the first, but having zero resistance (this "infinite bus" represents remote earth.) Connecting these two is a sheet conductor, having a uniform conductance of k mhos per megafoot, measured along the first two conductors. This lamina is considered to be conductive only in the direction perpendicular to the first two conductors, (and represents both the coating and the soil lying between the pipe and remote earth; it is the conductance value we are here trying to measure.)

From a point on the pipe, designated as the origin, let there be a current drained and discharged to the infinite bus. Let the value of this current be $2I_0$ amp; by symmetry, then, the current in the line immediately adjacent to the origin will be I_0. The drainage of this current will establish a potential difference between the line and the infinite bus. This potential will be greatest at the origin, and will diminish as the distance from the origin increases. Let the value at the origin be E_0 volts. At any distance x from the origin let the current in the line be designated by I_x and the potential between the line and the infinite bus be E_x.

At any given point x the current density through the coating is proportional to the potential at that point. This is the same as saying that the rate of current pickup, or the differential of current, is proportional to the potential; it is, in fact, given by the expression:

$$dI = -k\,E\,dx \quad . . . . . (4)$$

The change in potential with respect to the infinite bus, at any point, is equal to the change in potential in the line itself (because the infinite bus has no resistance); it is equal to the IR drop in the line, or

$$dE = -r\,I\,dx \quad . . . . . (5)$$

These two symmetrical equations are the basic differential equations for attenuation. Their general solution gives:

$$E = A\,e^{\alpha x} + B\,e^{-\alpha x} \quad . . . . . (6)$$

$$I = C\,e^{\alpha x} + D\,e^{-\alpha x} \quad . . . . . (7)$$

$$\text{where } \alpha = \sqrt{r\,k} \quad . . . . . (8)$$

and A, B, C, D are constants whose values are to be determined by boundary conditions, for specific solutions. In the case of an infinite uniform line $A = C = 0$, $B = E_0$, and $D = I_0$, so:

$$E_x = E_0\,e^{-\alpha x} \quad . . . . . (9)$$

$$I_x = I_0\,e^{-\alpha x} \quad . . . . . (10)$$

These are the basic attenuation equations for an infinite line. The attenuation constant, α, has the dimensions of *per megafoot.*

Equations 9 and 10, when plotted on semi-logarithmic paper (linear scale for x and log scale for E and I) both show up as straight lines. The attenuation constant α determines the slope of the line; the larger the value of α the steeper the slope. If the value of E, for example, is taken at two points a and b, then α can be found from the expression:

$$\alpha x = \log_e (E_a/E_b) \quad . . . . . (11)$$

where x is the distance between a and b.

α is thus characteristic of a given line; it can be seen by examination of Equation 8, which defines α, that the attenuation is higher for a high-resistance line, and for a line with high leakage conductance; maximum attenuation would be found on a light-weight bare line, and minimum attenuation on a heavy-weight line with excellent coating.

By substituting a different set of boundary conditions in the general solutions (6) and (7), or by other mathematical means, equations can be derived for the attenuation of current and potential along a finite line; that is, one that terminates in an insulated joint or an open end. The general expressions are:

$$E_x = \frac{E_0 \cosh \alpha (L - x)}{\cosh \alpha L} \quad . . . . (12)$$

$$I_x = \frac{I_0 \sinh \alpha (L - x)}{\sinh \alpha L} \quad . . . . (13)$$

where cosh and sinh refer, respectively, to the hyperbolic cosine and hyperbolic sine. Another useful relationship, in which the potential is defined in terms of the terminal potential instead of the initial value, is:

$$E_x = E_L \cosh \alpha (L - x) \quad . . . . . (14)$$

Since any point on such a curve may be taken as an origin, we also have:

$$E_o = E_L \cosh \alpha L \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

It will be noted that E and I as given by Equations 12 and 13 are not, as is the case with infinite lines, identical equations. That this is necessarily the case follows from the fact that I_L must be zero, whereas normally there will be a very real potential at an end.

When a finite line is quite long, the initial portion of it cannot be distinguished from an infinite line. The initial potential due to a given current is the same, the initial slope of the line is the same, and the line is essentially straight. Futhermore, the current and potential curves will be the same shape and the same slope.

As we go down the line, however, the potential curve gradually curves upward, and the current curve trends downward. The curvature becomes greater, and as the end is approached, the potential curve becomes quite horizontal, intersecting the end line squarely; the current curve goes off the bottom of the paper, since it must go to zero, and there is never a zero on a logarithmic scale, no matter how many cycles are used. It is interesting to note that, for a line long enough to have the characteristics described, the point at which the potential curve reaches the end and becomes horizontal is at a value that is exactly twice what the potential would be if the initial straight line continued without change to the end.

A still shorter finite line will differ from the above description. The initial potential will be higher than would that of an infinite or very long line with the same attenuation. The initial current, on the other hand, will be lower. Both curves will be sensibly curved at the beginning, and their slopes will be visibly different, the potential curve being the flatter of the two. As before, the potential curve will end horizontal, while the current curve will plunge to zero.

Finally, for a very short line, the potential curve will be essentially straight and horizontal for its whole length, and the current curve will be virtually non-existent.

It must be recognized that these different characteristics, of infinite, long, short, and very short lines, do not divide them into sharply delineated categories; there is a gradual transition of properties, and if any classification is to be set up, it necessarily must be on an arbitrary basis. The critical quantity is one that might well be called the "electrical length." This is the product α L; the attenuation constant multiplied by the length. It is of interest to note that this product is dimensionless; it is a pure number. It is further of interest to note that the value of α L for any given line is independent of the units used. If L is in feet and α in per foot, or if L is in megafeet and α in per megafoot, or even if L is in meters and α in per meter, then the product α L will, for any given line, always be the same.

Scope and Limitations of Measurements

It can be seen from the foregoing discussion that all methods of measuring conductance in place are based on certain assumptions of uniformity. If the coating is not in fact reasonably uniform throughout the section measured, then what is obtained will be an average—but not necessarily the average we would like to get. It will, in general, be a weighted average, in which part of the line has more influence than another part, but it will be difficult to assign any factors to the weighting. Nor can the problem be resolved by simply dividing the line up into shorter sections; there is a lower limit to the length of a section that can be measured, as will be seen later. We must then in most cases be content with an average over some length of line.

It has already been mentioned that the results obtained are strongly influenced by soil resistivity. At the present state of the art it does not seem advisable to attempt an actual correction factor, in the comparison of lines lying in different soils; but no report of a conductance measurement should be considered complete unless it includes data on soil resistivity.

These two problems combine to make it difficult to obtain precise measurements of the conductance of poor coatings. Variations in such coating are generally greater than in good coating, and the influence of soil resistivity, which is itself usually quite variable, is greater. It should be accepted as a basic limitation that the value for poor coating cannot be determined with comparable accuracy to that which is possible for good coatings.

An inherent difficulty in the whole problem is that the method which can be used is usually dependent upon the value of α L for the section involved; this value, of course, cannot be determined until the conductance is known. The only solution to this dilemma is that guess or estimate must be made, and the determination done according to the method appropriate for the estimated value. The results will either confirm the estimate or they will fail to yield a usable result; in failing, however, they will be sufficiently indicative that a second measurement can then be attempted using the correct method. This is neither a serious problem nor a unique one; after all, it is usually necessary to have some idea of the magnitude of a quantity to be measured in order to select the proper tool; we do not use a foot-rule to measure a continent, nor a surveyor's tape for a rug. The novelty here lies in the fact that it is sometimes impossible to distinguish in advance between a continent and a rug.

Leakage conductance can vary from as low as 1 mho per megafoot (even lower in some exceptional cases) to as high as 100,000 for a large bare line in low resistivity soil. Longitudinal resistance of pipe varies from below 1 ohm per megafoot for large heavy pipe to about 50 for light-weight 3-in. pipe. Combining these for maximum and minimum expected values of α, we find a range of more than 1000 to 1; values over a range of 200 to 1 are common.

(Part 2 will discuss Measurement Methods)

THE AUTHOR

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Bibliography

1. "Methods for Measuring Leakage Conductance of Coating of Buried or Submerged Pipe Lines," *Corrosion*, v. 13, p. 803t (Dec. 1957). Also available as NACE publication 57-27.

2. *Pipe Line Corrosion and Cathodic Protection*, Marshall E. Parker, Gulf Publishing Company, 1954.

Corrosion practices

NEW METHOD FOR LOCATING ELECTRICAL SHORTS AND OPEN COUPLINGS

DARREL D. BYERLEY, *Tinker & Rasor*

Disturbance of the null rather than signal level of audio frequency is basis of this different procedure

LOCATING UNDERGROUND ELECTRICAL contacts and open couplings on coated pipelines presents one of the major field problems in the installation and maintenance of a cathodic protection system. Finding and removing them often is time consuming and expensive.

This article describes an improved method and apparatus used in locating these electrical shorts and open couplings.

The usual technique has been to apply an audio frequency signal between the coated pipeline and a good earth ground. A traverse over the pipeline away from the audio frequency generator is made by walking over the pipeline with an inductor in the form of a coil, a suitable audio receiver, and ear phones. Audio current flowing through the coated pipe will cause an electrical field around the pipe, and by placing the inductance coil in a vertical position with reference to the pipeline, a strong signal is received. As departure is made away from the audio generator, the audio signal in the ear phones will diminish gradually depending on the condition of the coating and amount of audio energy that is being applied into the coated pipeline.

These conditions also have a bearing on the distance from the audio frequency generator the operator can travel without advancing the generator. While traverse is made away from the audio generator and a rapid drop in audio is noted, an electrical contact is assumed to be at this point. This method means that a rather broad difference in audio signal level has to be observed. Further differences in audio signal can occur from interference of other pipelines in close proximity to the coated system. All of which can contribute to inaccuracies in locating the electrical contacts or open couplings.

The New Method

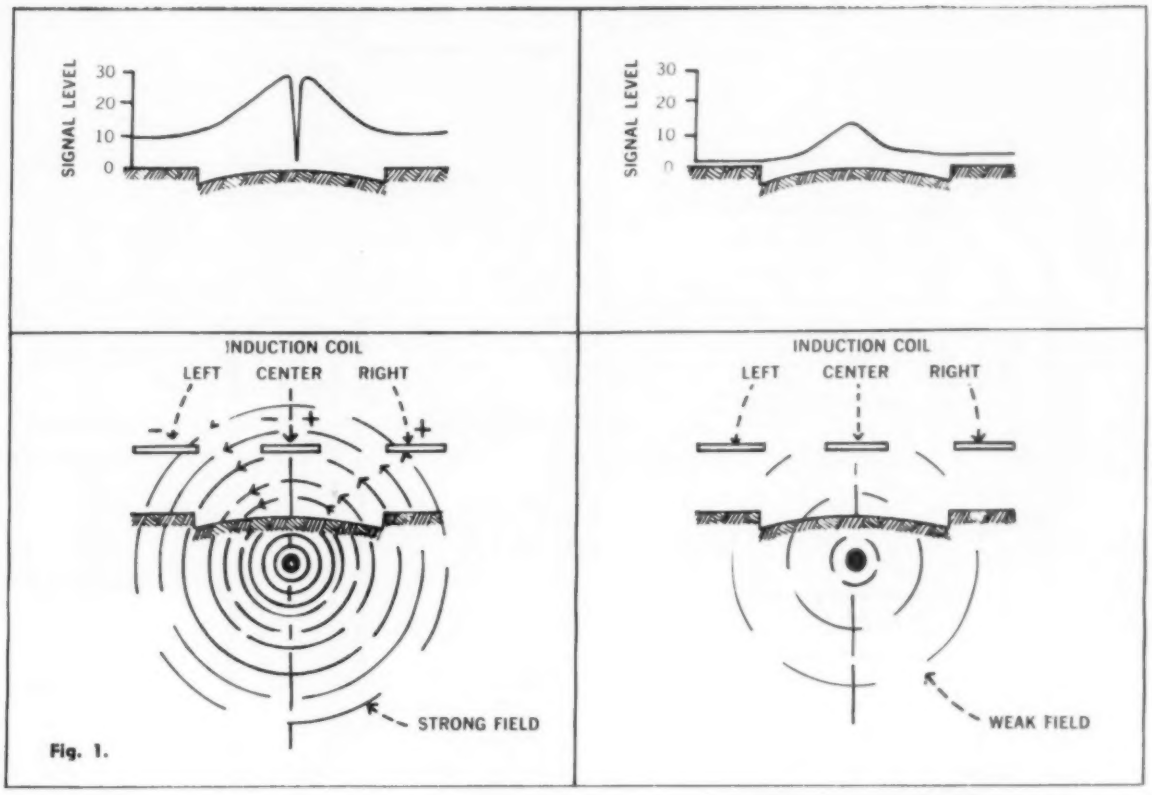
An improvement in the method just described can be made with substantially the same equipment, enabling the operator to locate the actual point of contact with a greater degree of accuracy and a considerable saving of time. This method does, however, require that audio energy of from 5 to 10 watts be available to apply to the coated pipe system.

When alternating current of audio frequency is caused to flow in a conductor, such as a pipeline, an electrical field exists around this conductor in a plane at right angles to the conductor (see Fig. 1). The intensity of the electrical field depends upon the amount of the audio current flowing in the pipe. This electrical field can be intercepted and measured by placing an inductance coil in the same plane as the coated pipe.

As the coil is moved back and forth at right angles to the pipe, the field is cancelled directly over the pipe and a null effect will be noted as long as a large amount of audio current is flowing in the coated pipeline. Using this null method, it is possible to follow the pipeline while a relatively large amount of audio current is flowing in it.

The new method looks for the disturbance of the null rather than maximum signal strength and, therefore, gives a sharper indication of the location of the electrical contact. If the coated pipe is in contact with a foreign system that is grounded, the audio current will leave the coated pipe at this point and flow in the foreign system. The same null effect will then be present on the foreign system as on the coated pipe from audio oscillator to point of contact.

As illustrated in Fig. 2, when the null is disturbed at a given point, a square traverse is made around this point to determine in which direction the audio current is leaving the system. If, in the course of this square traverse, a point


SIGNAL LEVEL
30
20
10
0
SIGNAL LEVEL
30
20
10
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INDUCTION COIL
LEFT
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RIGHT
STRONG FIELD
INDUCTION COIL
LEFT
CENTER
RIGHT
WEAK FIELD

Fig. 1.

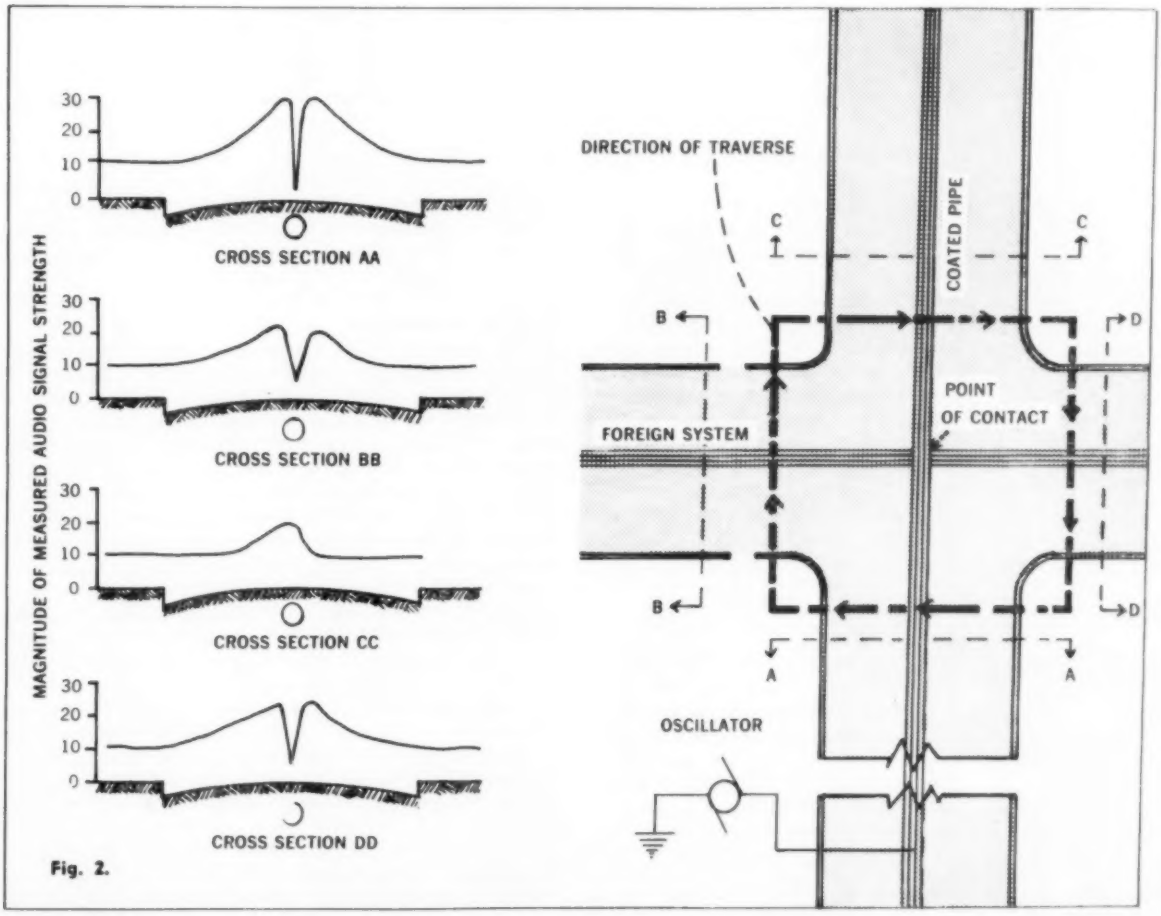
MAGNITUDE OF MEASURED AUDIO SIGNAL STRENGTH
30
20
10
0
CROSS SECTION AA
CROSS SECTION BB
CROSS SECTION CC
CROSS SECTION DD
DIRECTION OF TRAVERSE
COATED PIPE
C
B
D
POINT
OF CONTACT
FOREIGN SYSTEM
A
OSCILLATOR

Fig. 2.

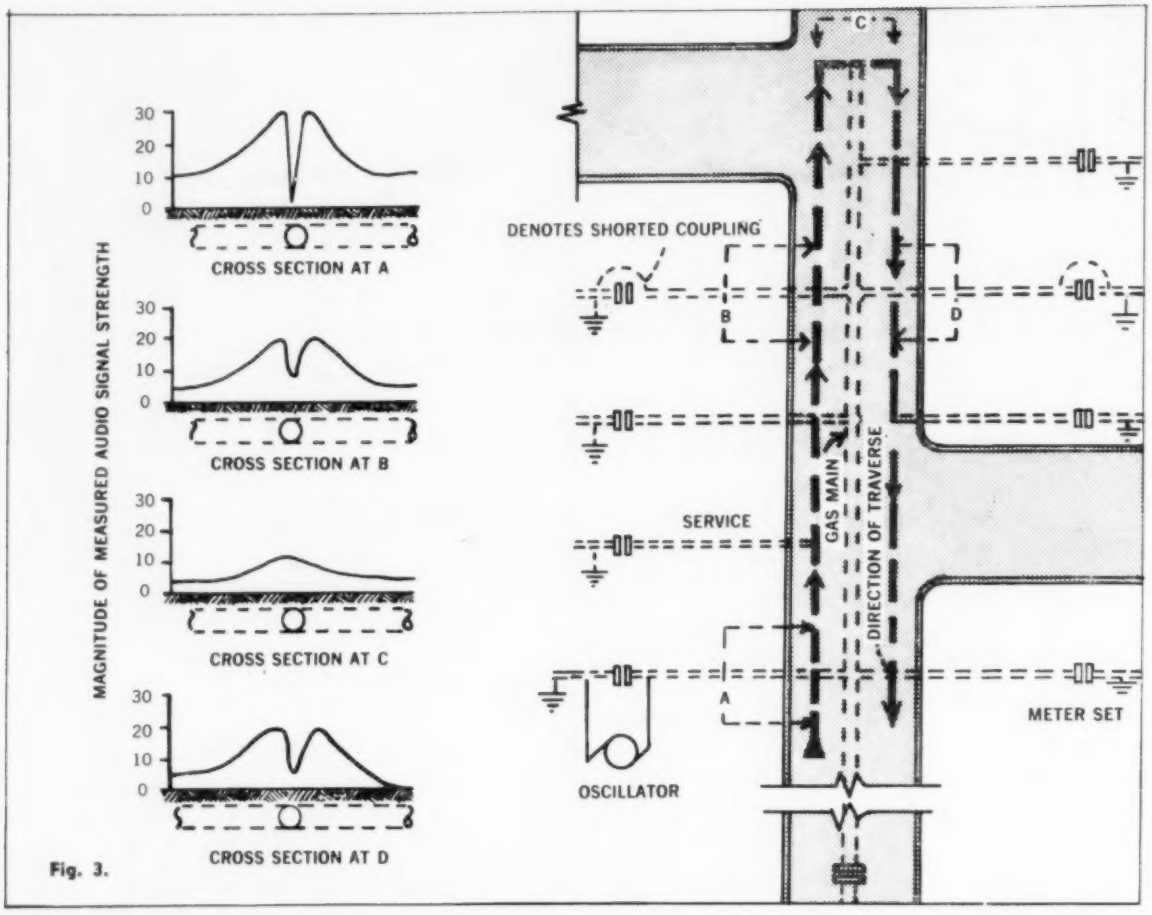

Fig. 3.

is reached where a null occurs, it is assumed that audio current is flowing through a member below this point. If no null effect is noted in the course of the square traverse, it can then be assumed a foreign member is lying parallel above or below the coated pipe and making contact with the coated pipe. Note in Fig. 2 that no high current flows beyond the point of contact in the coated pipe.

In many gas distribution systems, insulating couplings are installed at each meter set. Many of these systems are sectionalized by means of insulators in the gas main. It is possible to check the function of the insulators at the meter set with use of the null method. By placing the audio oscillator across an insulated meter set, an excellent ground is assured, as most gas systems on the dwelling side of the meter set are interconnected to a steel water system. A traverse is then made by crossing the service lines at right angles while remaining a few feet off the gas main. During this traverse the audio signal level will remain constant until a member conducting the audio current is crossed. At this point of crossing a null will occur. By following the current flow in this member using the null method, it is easily determined whether audio current is flowing past the meter set. Current flow beyond the meter set indicates the insulator is not functioning properly (see Fig. 3).

Testing Insulators

This method is also extremely successful in determining the insulating qualities of buried insulators (see Fig. 4). It has been observed where potentials were measured on each side of an insulated coupling, several hundred millivolts ± difference was noted. However, when an audio current of 5 to 10 watts was applied to the coated system, it was noted that audio current was flowing through this insulated flange. With tests conducted, it can be understood that this insulated coupling was considered a relatively high resistance open coupling. Potential measurement alone might indicate that this insulator was satisfactory. At a frequency of 750 cycles only a small amount of current flows through an insulator by capacitance, so that when a sharp null is obtained on the opposite side of the insulated flange, low resistance or a short is indicated.

If many electrical contacts or open couplings are present on a coated piping system, they may have to be corrected in sequence or the audio oscillator must be advanced to another location as the audio current will follow the path of least resistance back to the ground system of the audio oscillator.

Investigate Thoroughly

It is recommended that all suspected points of electrical

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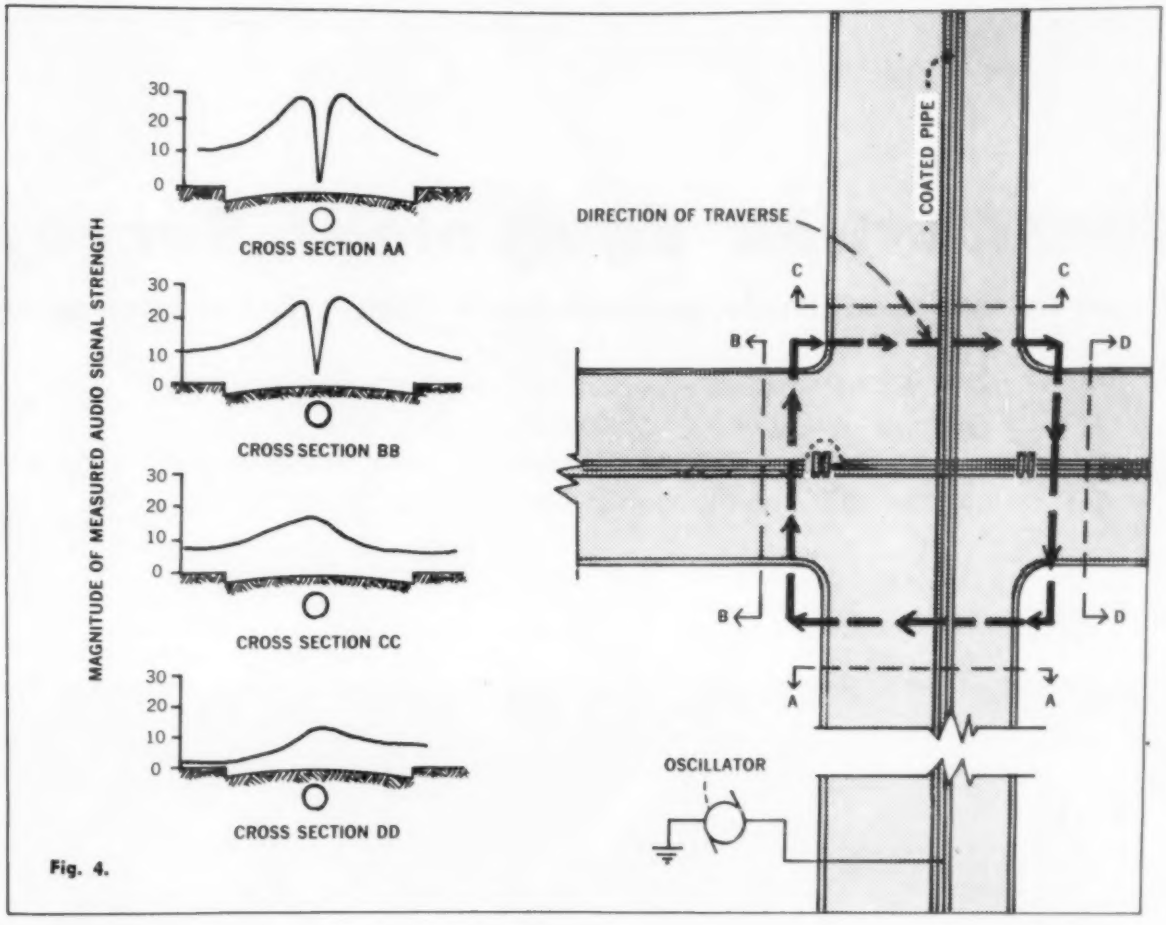


Fig. 4.

contact or open couplings be investigated thoroughly. This can be accomplished by advancing the audio oscillator beyond the point of null disturbance and tracing the audio current flow in the coated pipe back to the original point of null disturbance.

If the null disturbance lies at the same point after traverse from both directions, it can be assumed that the fault lies beneath this point.

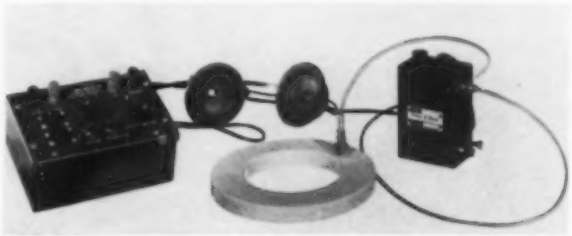
If the point of null disturbance appears to be caused from contact with a foreign underground system (which is indicated by the square traverse around the point of disturbance, Fig. 2) the audio current can then be applied to the foreign system and traced back to the coated pipe.

If audio current is flowing from the foreign system to the coated pipe, a null disturbance will be noted at the point of electrical contact. A thorough investigation can be made in a reasonable period of time and will substantiate each point of null disturbance.

When audio current of 5 to 10 watts is applied to a coated pipe, the distance between the coated pipe and the induction coil has little effect on the null method. This method has been used and proven to depths of 35 ft in surveys locating offshore lines.

It might be well to note that many electrical contacts and open couplings are located above ground. Usually the contacts are located where the coated pipe enters a building or is in contact with metal straps at bridge crossings, which in turn are connected to reinforcing steel in the concrete. In either case, whether these faults lie above or below ground, the audio current flowing in the conductor can be followed.

In brief, the null method follows the flow of audio frequency current in a coated pipe, determines where it leaves and indicates where it contacts a foreign line. The point of discharge is determined by a sharp disturbance of the null itself rather than the signal level of the audio frequency.



Apparatus used in performing the survey

This method is quite practical, particularly as competent corrosion field personnel can interpret their findings quickly and accurately.

There are several primary features that are desirable in the apparatus used for locating electrical contacts or open couplings accurately with minimum time:

1. Audio generator capable of applying 5 to 10 watts of stable audio frequency.
2. Output voltage selector switch for proper impedance match to the pipe load.
3. Interrupter.
4. Receiver equipped with filters resonate to the frequency of the oscillator.

* * *

Construction Equipment Survey

of gas transmission, crude/products trunk lines, pipeline contractors

Intensive industry-wide survey of construction/maintenance equipment utilization and replacement covers 60% of nation's gas transmission pipelines, 78.5% of the crude/products lines and 50% of the major pipeline contractors' spreads.

Frank H. Love, Editor

Reconditioned equipment ready for the next project... maintenance cost is one of several criteria for determining when equipment should be replaced.

Photo by Tenny Studio, Dallas

How much of what types of construction/maintenance equipment are used in the pipeline industry — by contractors, crude and products lines, and gas transmission lines? And how are they used?

To find out, the editors of PIPELINE ENGINEER in the past six months have conducted an extensive, intensive study of operating crude pipeline companies, refined products pipeline companies, gas transmission companies, and pipeline contractors to determine exactly what they use and how they use it.

We wanted to know, in detail:

- The sizes, ratings, styles, and quantities of all construction equipment items used, item-by-item, in building and maintaining lines.
- If contractors and operating companies used equipment for the same purposes.
- If uses of certain equipment items might be obscure and not of general industry knowledge. (We found quite a few.)
- What various criteria are used for determining when equipment should be replaced, and how often is it replaced?
- Who buys or specifies equipment in both contracting firms and in operating companies.

Study Results

To accomplish such a task involved conducting a large scale survey of some 200 operating companies and some 250 contracting firms.

Survey results were supplemented by personal contacts with many operating company and contractor executives, engineers, and supervisory personnel to obtain "on the job" information.

Data in this report is based on exceptionally large and representative samples of all types and sizes of operating companies and contractors.

Represented in this report are:

1. **Contractors** having a total of 399 spreads; 156 of these spreads are equipped for laying pipe of 24-in. or larger diameter, and 243 spreads are for pipe under 24-in.

2. **Gas transmission companies** operating 103,259 miles of a total of 174,360 miles in the U. S. . . . or 60% of the total. These transmission companies, incidentally, operate 59,389 miles of pipe over 16-in. diameter (57.5% of their total operated mileage) and have installed over 31% of their total mileage (about 33,000 miles) in the past 5 years.

3. **Crude oil and/or refined products pipeline companies** operating 103,414 miles of a total of 131,800 miles in the U. S., or 78.5% of the nation's total.

Publication of all the data and evaluations of such an extensive study would not be possible in one article or even one complete issue. For the reader's benefit, the following report highlights the findings of the study and gives brief explanations.

EQUIPMENT REPLACEMENT

When should equipment be replaced? What criteria apply?

Generally, both contractors and pipeline companies apply certain universal yardsticks: Age, condition, maintenance cost, depreciated value, and actual value.

Pipeline contractors replace equipment most frequently of all groups. Equipment used in laying pipelines — whether "big inch" or small gathering lines — sees hard service even under the best of care. A reasonable "rule of thumb" used by many contractors is that most equipment will last for 200 miles of large diameter pipeline construction and, probably 300 miles of small diameter construction. Working conditions, terrain, etc., all play a part.

Contractors' equipment, such as tractors and trucks, is often replaced every two years. Attachments, accessories, and other appurtenances may last 3 or 4 years before being replaced. Backhoes, welding rigs, air compressors, cranes, etc., generally are replaced after 3 to 5 years service. Small tools may last anywhere from 1 year of service to 10 years.

Gas transmission companies do not put their construction and/or maintenance equipment to as severe a service test as the contractors. Trucks, for example, are replaced after 3 to 5 years service, averaging about 4 years. Condition and maintenance cost generally are more important criteria than age.

The transmission companies replace tractors, backhoes and cranes, air compressors, and similar equipment less frequently, too. Wheel-type tractors, used for light maintenance work, grass mowing, snow plowing, and light excavation, generally last an average of 10 years before being replaced. Heavier track-type tractors are replaced after 8 to 10 years service. Backhoes and cranes, air compressors, welding rigs, and similar equipment last from 8 to 12 years before replacement.

Crude oil and/or refined products pipeline companies apparently use their equipment more than the gas pipeline companies. Average replacement times for track-type tractors is 4 to 7 years, with attachments lasting an average 5 years. Wheel-type tractors, used with backhoes and front-end loaders for excavation and backfilling, are replaced approximately every 5 years. Backhoes and cranes have an average service life of 7 to 8 years. Air compressors, welding rigs, sump pumps, etc., are replaced when their service is no longer economically justified by repairing . . . the range is 4 to 8 years. The liquid pipeline companies replace trucks every 3 to 4 years.

CONTRACTORS

Largest overall users of construction equipment are the pipeline contractors.* Here's what they own and operate:

Tractors

Track-type Tractors. Laying pipelines requires a wide range of track-type tractors — in sizes from less than 50 hp to those in excess of 150 hp. In a typical spread, having about 25 tract-type tractors, approximately 10% will have ratings of 50 hp or less; 32% will be 50 to 100-hp units; 37% are 100 to 150-hp units, and 21% are over 150 hp. Number of tractors per spread ranges from up to 40 for a "big-inch" spread to as few as 7 for a small-inch spread.

These tractors are equipped with numerous attachments: *Front-end loaders, side booms, dozer blades, hydraulic back-*

*This report covers only *pipeline* contractors engaged basically in the installation of gas transmission lines, crude oil and refined products lines, and crude and natural gas gathering lines. *Distribution* contractors, who engage primarily in construction of city distribution system mains and services, are reported in the March 1961 issue of AMERICAN GAS JOURNAL, companion publication of PIPELINE ENGINEER.

Equipment in contractor's warehouse yard awaiting shipment to a new job. These are but a few of the many items required to construct a pipeline system.

hoes, winches, machine trenchers, rippers, rakes for rock and brush, arc-welding generators, and top-mounted revolving cranes.

Sidebooms are a principle requirement, and about 47% of the tractors are so equipped. But pipelines could not be built without dozer blades — and approximately 32% of the tractors have them. The same is true of winch attachments, with about 32% of the tractors so equipped.

In recent years the practice of mounting *arc-welding generators* on tracks has come into vogue to a marked degree and some 16% of the tractors in a spread are used for this purpose.

Other attachments mentioned are for specialized functions and, consequently, are used to a lesser extent.

Wheel-type Tractors. Wheel-type tractors are employed in pipeline construction to a greater extent than is generally realized. They range in size all the way from less than 30 hp to in excess of 100 hp, and are equipped with *front-end loaders, backhoes, sidebooms, dozer blades, fork lift, winches,* and, in a few instances, *vertical augers.*

Uses include towing welding machines, pulling discs and harrows in right-of-way cleanup work, padding ditch, grinding bevels, and pulling small air compressors and chisels. The number per big-inch spread — which averages about 2 — depends largely on whether welding generators are pulled by them or are mounted on track-type tractors, and whether the condition of the terrain requires considerable ditch padding. On small-inch spreads, wheel-type tractors with backhoes or sidebooms are used, especially on gathering line installation.

Trenchers

Principal style of **trencher** in use today is the track-mounted *wheel-type.* There is an average of about two trenchers per spread . . . sometimes both are in action at the same time, sometimes one acting as a spare. Approximately 30% of the ditchers in use will dig a ditch 18 in. wide and 5 ft deep; 25% 18 to 36 in. wide by 6 ft; and 45% over 36 in. wide by 6 ft deep. *Ladder-type track-mounted ditchers* find their biggest use in gathering system construction.

Other Excavating Equipment

Excavating equipment used in addition to trenchers includes *backhoes, draglines, clamshells,* and *cranes.*

Fully 92% of the **backhoes** are crawler-mounted, and 92% have capacities of less than 1 cu yd. Of the other 8%, about 6% have capacities of 1 to 2 cu yd, and 2% capacities over 2 cu yd. Carrier-mounted backhoes are in limited use and extremely few self-propelled units are employed. Depending upon the conditions under which the contractor is working and the size of the spread, there will be from three to seven backhoes in a spread.

Few **dragline** units of 1 to 2 cu yd capacity are used in pipeline construction, the popular sizes being under 1 cu yd.

Clamshells are almost entirely of less than 1 cu yd capacity.

Cranes are of several kinds and mountings — self-propelled, truck-mounted, crawler-mounted, and hydraulic types mounted on flat bed trucks.

Self-propelled units constitute about 34% of the cranes used by contractors, and, of these, 24% are under 3-ton capacity and 10% over 10 tons.

Crawler-mounted cranes account for 32% of the total, virtually all 3-tons or under, although there are services that must be performed by cranes of 3 to 10-ton and over 10-ton capacities, and there are a small number of these.

Although *truck-mounted cranes* comprise only 18% of the total, units generally are in the larger sizes — 7.9% being 3 to 10-ton capacity, 6.5% over 10-ton, and 3.6% under 3-ton. *Hydraulic cranes* mounted on flat bed trucks compose 16% of the overall total.

Backfilling Equipment

The customary method of backfilling a trench is with **crawler-mounted backfillers** and **motor graders,** in about equal numbers, with one unit of each type to a spread usually sufficient. Under certain conditions auxiliary equipment also is needed.

When terrain is rocky and the ditch must be padded, *padding machines* are used to sift rocks from the spoil bank, and *scrapers* and *tractors,* (the latter equipped with front-end loaders), haul suitable dirt for padding and shad-

ing the pipe to prevent coating damage. Under some circumstances a *dragline equipped with a backfill bucket* is employed for backfilling.

Tamping Equipment

Each construction spread has one or two units for tamping soil . . . on the larger spreads the average is two units. Approximately 67% of the units are *pneumatic tampers*. The other 33% is divided fairly evenly between *gasoline-powered tampers, self-propelled heavy-duty tampers,* and *pavement rollers* for road repairs. In addition, a limited number of *sheeps-foot roller tampers* is used.

Air Compressors

Most popular types of **air compressors** are *rotary* and *reciprocating,* in that order; *centrifugal compressors* are in limited use. Approximately 55% of the air compressors are rotary, 39% reciprocating, and 6% centrifugal. The larger capacity units serve best in pipeline work. Some 40% have capacities exceeding 210 cfm, 36% have capacities from 110 to 210 cfm, and 24% are rated 105 cfm or less.

Most generally accepted method of mounting air compressors is on trailers . . . about 74% being made mobile by this means. The remaining 26% are either tractor-mounted, truck-mounted, skid-mounted, or hand-carried. Truck-mounted and portable hand units are used the least.

Pneumatic Tools

The above air compressors provide power for operating a variety of **pneumatic tools,** including *rock drills, wagon drills, paving breakers, grinders, spade-type diggers, chipping hammers, wire brushing machines, saws* and *backfill tampers*.

Important to a contractor is equipment for making shot holes for blasting rock. Sometimes rock is visible, or known to exist beneath the surface, and ample equipment is moved in to cope with it. At other times it is sporadic and its exact location not always known. But the contractor must be prepared to handle any situation. Usually there are three or four *single rock drills* available to a spread and one or two *wagon drills*. Some contractors also have twin drills and quad drills. Obviously, the contractor moves this equipment about among his spreads as circumstances dictate.

When federal or state highways must be crossed, they are tunnelled under, of course, and this is true of many roads of lesser importance. However, certain types of roads can be ditched, which accounts for *paving breakers* being an essential part of the contractor's equipment — two or three units to a spread.

The other pneumatic tools listed are used in approximately these average quantities:

Grinders — 2 per spread
Diggers, spade-type — 2 per spread
Chipping hammers — 1 per spread
Wire brushing machines — 2 per spread
Hand saws — 1 per spread
Backfill tampers — 1 per spread

Gasoline Engine-Driven Tools

Large skid-mounted (or similar) **pumps** and **portable sump pumps** are used for removing water from ditches and draining water from the right-of-way in swampy areas. The average spread will have one portable sump pump and two large skid-mounted units available.

Chain saws have greatly speeded up right-of-way clearing in comparison with past years when the ax was the prime instrument for felling trees. The average crew will have four or more in operation.

Pipe Cutting, Bending

Lining up pipe joints for welding would sometimes be impossible without the **cutting and beveling machine;** when pipe ends become out-of-round from handling, it is necessary to cut out and re-bevel the damaged part. It is often necessary, also, to cut out part of a joint at the tie-ins to bring the pipe to the proper fit. These and other uses explain the large number of such machines, between eight and nine to a spread, actually in use or available.

Most large contractors own their **pipe bending equipment,** although it can be rented. On the bigger spreads there usually is one machine. Sometimes two spreads work close enough together that the bender can be interchanged as needed. These machines are either mounted on crawlers or skids.

Small hand-operated pipe benders are used principally in the laying of gathering lines. **Pipe straighteners** are invaluable in reconditioning old pipe, which some contractors do as well as constructing new pipeline systems. And when the reconditioned pipe is re-laid they are also needed when joints have not been properly straightened in the reconditioning yard.

Coating and Wrapping Pipe

Probably not more than one-fourth of the contractors own their **coating and wrapping machines.** The reason is simple: Until comparatively recently, patent rights made use of such machines possible only on a rental basis.

Some contractors do own this equipment now, however, as certain patent rights have expired, and it seems quite possible that more will in the future. The fact that most contractors own their **cleaning and priming machines,** which are run just ahead of the coating and wrapping equipment, and on which there are no purchase restrictions, might be considered a criterion for this observation.

Other factors influencing the small ownership of coating and wrapping machines are the growing trend to double-jointing and coating pipe in central yards and the sub-contracting of coating application whether performed in the yard or on the right-of-way.

Tapes are a relative newcomer in the field when compared with some other types of coatings, and for this reason few **tape wrapping machines** are owned as yet. Much of this work is sub-contracted. A limited number of contractors, however, do own powered tape-wrapping machines for larger diameter pipe and manual tape-wrapping machines for the smaller pipe, such as gathering lines.

Welding Equipment

For welding pipe joints the **d-c arc welder** is favored almost four to one over **a-c welding generators** — 78.5% as opposed to 21.5%. Some contractors have found that *track-mounted equipment* has certain advantages, especially in mud and snow, but the practice is not too old and has not been adopted to the degree it may be in the future. *Skid-mounted and truck-mounted welding generators* are almost equally popular, with an impressive number equipped with wheels. These are the percentages:

Skid-mounted, 37%;
Truck-mounted, 34%;
Trailer-mounted, 20%, and
Track-mounted, 9%.

To position the pipe for welding, a variety of **line-up clamps** are used . . . *manual internal and external clamps,* and *hydraulic and pneumatic internal clamps*. Manual external clamps constitute 85% of those used; manual internal clamps, 11%, and the remaining 4% is divided between hydraulic and pneumatic internal clamps.

Other Equipment, Tools

The equipment already enumerated totals hundreds of items, but there are still others the contractor must have to do a complete pipeline construction job:

Electronic pipe locators, so he will not damage another pipeline in the same locality.

Holiday detectors to test the insulation coating on the pipe.

Dope kettles, three or more to a spread, so there will always be hot coating ready, if hot coating is being used.

Pipe tapping and plugging machines.

Road boring equipment, which may be of direct, pneumatic, or hydraulic drive. A part of this work, incidentally, is sub-contracted.

Clay augers.

Well-pointing equipment for river crossings or for work in wet or swampy country.

Portable electric tools, some used in the shop, some in the field . . . *buffers, grinders, drills, saws, hammer wrenches, etc.*

Transportation Equipment

"You name it and we have it" could well describe the great variety of **automotive equipment** employed by pipeline contractors, ranging all the way from compact cars to trucks of 10 tons and over.

Criteria for replacement of automotive equipment include:

1) Condition, 2) age, and 3) mileage.

This is varied in some instances by some contractors who replace passenger cars and pickups on a regular time schedule while holding to a "condition" yardstick for larger trucks.

Transportation equipment is largely owned outright by the contractor, although some is leased. The ratio is approximately 94% owned and 6% leased for trucks; 92% owned and 8% leased for passenger cars.

Based on gross vehicle weights, percentages of trucks owned are as follows:

0 to 10,000-lb (light)	63%
10,000 to 19,000-lb (medium)	26%
19,500-lb and over (heavy)	11%

Body styles include: *Panel trucks, pickups, Jeeps, vehicles with crew bodies, vehicles with service bodies, highway tractor units, flat-beds and/or stake bodies,* and *dump.*

Numerically, pickups and flat-beds lead the group, followed by vehicles with service bodies, highway tractor units, Jeeps, dump, vehicles with crew bodies, and panel trucks.

Semi-trailers include several types: *Van, pipe or pole, flat-bed, low-boy, winch.*

Large mobile trailers, utilized for spread offices and living quarters, are a part of every spread doing cross-country pipeline construction where moves are frequent.

By far the most popular type of **passenger car** is the *four-door sedan.* Four-door sedans represent 72% of the total in use, two-door sedans 17%, and two-door sedan compacts 11%.

GAS TRANSMISSION PIPELINES

As stated previously, this survey is based on reports from gas transmission companies operating 103,259 miles of pipeline, 60% of the nation's total. Total mileage in operation is 174,360, according to the latest available American Gas Association figures.

Gas transmission pipelines are constructed almost 100% by contractors. In replying to PIPELINE ENGINEER'S survey, only two companies built any of their own lines. One company said it had laid about 5% of its lines during the last five years, another said 1%. For all other companies, installation was entirely on contract.

In the case of **gas gathering lines,** the facts are a little different. Overall, operating gas pipeline companies lay about 4% of their gathering lines. Some companies do as much as 20% of this work themselves, others as little as 1%, and many contract gathering lines entirely.

On the whole, operating companies own construction-type equipment for maintenance purposes. For this reason, although they own most of the same items as contractors, they are in considerably fewer numbers.

Gas pipeline companies own anywhere from 2 to 57 track-type tractors, depending upon their pipeline mileage. On an average, one tractor is used to maintain 320 miles of pipeline. Approximately 64% are in the 50 to 100-hp classification; 22% under 50-hp; 10% 100 to 150-hp, and 4% over 150-hp.

Most popular attachments are *sidebooms* and *dozer blades.* Approximately 43.3% are equipped with dozer blades and 21.8% with sidebooms. Many are equipped with both. Other attachments include *front-end loaders, hydraulic backhoes, winches* (23.3%) and a few *rippers and trenchers.*

Wheel-type tractors find many uses in light maintenance work. With the proper attachments they are used principally for:

1) Mowing right-of-way and compressor **station yards,** which includes cutting brush and weeds;
2) Light dozer work;
3) Snow plowing;
4) Digging holes (for anode placement) and ditches;
5) Trenching and backfilling for small lines, cables, etc.;
6) Loading and unloading materials;
7) Maintaining backfill;
8) Grading;
9) Dirt loading;
10) Terracing;
11) Maintaining roads.

On an average, one wheel-type tractor is used for each 191 miles of gas pipeline. Units having horsepower ratings of 30 to 60 predominate, comprising 61% of those in use. Tractors having ratings of less than 30 hp make up 33% of the total, 60 to 100-hp units 5%, and those over 100 hp only 1%.

As indicated by uses enumerated above, they are provided with attachments that include *front-end loaders,* (42.6%) *hydraulic backhoes* (22.7%), *dozer blades* (52.2%), *cutters, snow plows, augers, drills, and mowers.*

Trenchers

Because of the nature of maintenance work, few **wheel** or **ladder type trenchers** are owned by operating gas companies. Any necessary trencher requirements are taken care of by small, portable, chain-type trenchers or mobile trencher attachments on tractors.

Other excavating equipment consists of **backhoes, draglines, clamshells,** and **cranes.** *Many are combination units.* For example, one company reported having 10 basic units (four self-propelled and six crawler-mounted) with interchangeable backhoe and dragline equipment for each unit. Others use crawler-mounted backhoes, draglines, and clamshells in combination.

Tamping Equipment

Tamping equipment is almost entirely of the pneumatic type. The need is limited and about one unit per 1000 miles of pipeline suffices. Gasoline-powered tampers are used on a very small scale, as are sheeps-foot tampers and pavement rollers.

Air Compressors

An average of one **air compressor** is used for every 280 miles of gas pipeline. Approximately 84% are reciprocating units, 14% rotary, and 2% centrifugal. In capacities, 51% are rated 105 cfm or less, 48% 110 to 210 cfm, and 1%

over 210 cfm. The favorite method of making them portable is to mount on trailers, which represents 65% of the units. The remainder are either stationary, skid-mounted, or small hand-carried compressors.

Pneumatic Tools

Pneumatic tools powered by these air compressors include *rock drills, paving breakers, grinders, spade-type diggers, chipping hammers, wire brushing machines,* and *backfill tampers.*

Gasoline-Driven Equipment

Principal gasoline engine-driven equipment and tools are *portable sump pumps, portable electric generators, chain saws,* and *large skid-mounted (or similar) pumps.*

Approximately one **portable sump pump** is used for each 209 miles of line. Larger skid-mounted units are utilized in lesser degree — in a ratio of about 1:5 in comparison with the portable units.

One **portable electric generator** is used for each 372 miles of pipeline, 90% having ratings of 5 kw or less, and 10% over 5 kw.

Chain saws, for right-of-way clearing principally, average one for 1209 miles of pipeline.

Pipe Handling

Maintenance crews require a miscellaneous assortment of equipment and tools to handle pipe — for cutting, beveling, bending, straightening, line-up, cleaning, taping, etc.

Line-up clamps are almost entirely of the manual external type (99.5% of the total), with a smattering of hydraulic internal line-up and manual internal line-up clamps. Approximately one unit is required for every 77 miles of line operated.

Approximately one **cutting and beveling** machine is used per 241 miles of gas pipeline.

Other pipe handling equipment is owned as follows:

Bending machines, large, crawler and skid-mounted.
Pipe benders, small, hand.
Pipe straighteners.
Cleaning and priming machines.
Manual tape-wrapping machines (for small diameter pipe).

Other Maintenance Equipment

Other maintenance and construction equipment are used in these approximate quantities:

Electronic pipe locators..1 unit per 702 pipeline miles.
Holiday detectors.....1 unit per 1613 pipeline miles.
Pearson-type holiday detectors.....few.
Dope kettles.....1 unit per 501 pipeline miles.
Pipe tapping and plugging machines....1 unit per 384 pipeline miles.
Well-pointing equipment.....few.
Portable small electric tools..1 unit per 54 pipeline miles.

Welding Equipment

For **electric welding,** about 95% of the generators are direct current, the remaining 5% alternating current. Of the two types, one unit is in use for every 175 miles of pipeline. Most popular mounting is on trucks (36.5%), followed by skid-mounted (33.4%), and on wheels (30.1%).

Oxy-acetylene welding equipment is in wide use for making repairs to equipment and is found on all mechanic's trucks and in shops. Their use averages one unit for every 174 miles of pipeline.

Transportation Equipment

Operating companies have a few *compact cars* in service as **passenger vehicles,** but the popular type continues to be the regular *four-door sedan.* These companies have one passenger car for about each 32 miles of line and 70.3% of them are four-door sedans. *Two-door sedans* comprise 16% and *station wagons* 12.9%. The remaining fraction of a percent is about evenly divided between *compact four-door sedans* and *compact station wagons.*

Interesting to note, also, is that pipeline companies own 78.8% of their passenger units and lease 21.2%.

The owned-leased ratio in **trucks** is close to that of passenger cars: 81% owned and 19% leased. Predominating are those having gross weights to 10,000 lb (74%), followed by medium trucks of 10,000 to 19,500 lb (20%), and heavy trucks of 19,500 lb and over (6%).

In **body styles,** *pickups* lead with 59% of the total. Next are *flat-beds and/or stake bodies,* 18%; *vehicles with service bodies,* 7.6%; with *crew bodies,* 7.3%; *highway tractor units,* 4%. The remaining 4.1% consists of *Jeeps* and *panel trucks* in about equal proportions, with a few *dump trucks.*

Trailers of the kind used for *mobile offices or homes* number about one unit per 1000 miles of pipeline.

In **semi-trailers,** *pipe* or *pole* is the most common type in use (59.5%), with *flat-beds* comprising 22.5%, and lowboys 18%.

Replacement of trucks and passenger cars is based variously on condition, mileage, and age. Within these categories, however, there is a wide range of practice. Passenger cars are generally traded in after being in service from 45,000 to 100,000 miles and in age from two to five years, depending upon the policy of each company. The averages are 60,000 miles and four years. Light and heavy trucks are replaced after 50,000 to 100,000 miles or from three to five years.

CRUDE AND PRODUCTS PIPELINES

There are approximately 131,800 miles of crude and refined trunk pipelines in operation in the United States — 81,800 miles of crude and 50,000 miles of products. PIPELINE ENGINEER's survey is based on reports received from companies operating 103,414 miles of these lines.

Some operating companies contract major construction and maintenance work involving heavy equipment, but not all. Few do any trunk line construction. The practice actually, is almost non-existent. The ones reporting that did their own construction laid a total of only 20.1 miles last year and 82.4 miles during the last five years. The rest was contracted.

In the case of gathering lines, more are laid by company crews than is true of trunk lines because the equipment on hand can handle the smaller pipe; here also, however, the big percentage of the work is contracted. Most of the equipment owned by these companies is for maintenance purposes.

Tractors

Track-type. One tract-type tractor unit is required to service 1149 miles of pipeline, and these are largely in the small or medium sizes. Our figures show that 46.6% have ratings of less than 50 hp, 33.9% ratings of 50 to 100 hp, 8.2% 100 to 150 hp, and 11.3% over 150 hp.

These tractors are equipped with **attachments** as follows: *Dozer blades* 66.6%; *sidebooms,* 54%; *hydraulic backhoes,* 14.4%; *winches,* 21.1%; a few with *front-loaders, top-mounted revolving cranes,* and *rippers.* That these percentages add up to more than 100 is due to the fact that many of the tractors have more than one attachment.

Wheel-type. Wheel-type tractors are used for many purposes — grass and weed mowing, leveling sites for tanks, stations, etc., ditching, digging bellholes, grading roads and right-of-way, picking up and lowering pipe, excavating, backfilling, snow plowing, and landscaping.

One unit is used for each 533 miles of pipeline. Of these, 23.8% are less than 30 hp; 70.4% are 30 to 60 hp; and 5.8% are 60 to 100 hp.

Attachments include: *Front-end loaders,* 30%; *hydraulic backhoes,* 47.6%; *dozer blades,* 23.5%; *fork lift,* 5.2%; *snow plows,* 5.2%; *mowers and/or drags,* 10.6%.

Trenchers

The need for **trenchers** is limited and the average is one unit per company. Types in use are predominantly wheel-type and track-mounted ladder-type. Also used are a few small portable chain-type and machine trenching attachments used on wheel-type tractors.

Other Excavating Equipment

Approximately one **backhoe** is owned per company, almost entirely of less than 1 cu yd capacity. Mountings are: Crawler, 54.8%; carrier, 32.2%; self-propelled, 13%.

Dragline units are used by about half the companies and **clamshells** in like numbers. In both instances, capacities are almost entirely under 1 cu yd.

Cranes are also owned by approximately half the operating companies, and are almost wholly crawler-mounted. They are all under 3-ton capacity.

Backfilling Equipment

As has been indicated, most backfilling is done with *dozer blades* on track-type and wheel-type tractors, and *front-end loaders* on the wheel-type. There are, however, a few *crawler-mounted backfillers* and *motor graders* used for this purpose.

Tamping Equipment

Tampers are 95% pneumatic. Other types are gasoline-powered and pavement rollers for road repairing. Overall, approximately one tamping unit is required for each 1361 miles of pipeline.

Air Compressors

Air compressors are in popular use as they power the numerous pneumatic tools necessary for repairing equipment. The ratio is one unit per 522 miles of pipeline. Reciprocating compressors are the most prevalent, 62.2% of the total; rotary, 27.2%; and centrifugal, 10.6%. By capacities: 60.1% are rated 105 cfm or less; 34.3%, 110 to 210 cfm; and 5.6% over 210 cfm.

In most instances they are trailer-mounted; in lesser degree, skid-mounted, tractor-mounted, or truck-mounted; and there are some hand-carried units.

Pneumatic Tools

Pneumatic tools owned by operating companies include rock drills, paving breakers, grinders, spade-type diggers, chipping hammers, wire brushing machines, saws, backfill tampers, concrete vibrators, and sump pumps.

Gasoline Engine-Driven Equipment

One **portable sump pump** is owned for each 379 miles of pipeline operated.

One **portable electric generator** will service 646 miles of line. Of the total, 92% have an output of 5 kw or less, and 8% over 5 kw.

Chain saws are owned — one unit per company average.

Large skid-mounted (or similar) pumps — one unit per 343 miles.

Pipe Handling, Servicing

Pipe handling and servicing equipment include:

Pipe saws.
Pipe cutting and beveling machines.
Pipe bending machines, large, crawler or skid-mounted.
Pipe benders, small, hand.
Pipe straighteners.
Line-up clamps.
Cleaning and priming machines.
Coating and wrapping machines.
Manual tape-wrapping machines.
Powered tape-wrapping machines.

Welding Equipment

Direct-current arc-welding equipment predominates, as in the case of contractors and on gas transmission systems, being 87.4% of this type; the remaining 12.6% are of alternating-current types. An average one arc-welding unit is required per 290 miles of pipeline. They are mounted on wheels, trucks, or skids in about equal numbers, with a few track-mounted and trailer-mounted.

One **oxy-acetylene welding unit** is owned for each 308 miles of line.

Transportation Equipment

Mileage, condition, and age determine when trucks and passenger cars are replaced. Some companies simply replace when maintenance of the vehicle becomes excessive, but most apply a mileage or age yardstick or a combination of the two.

Large trucks are replaced between 60,000 and 80,000 miles, although in some cases they are made to last for 125,000 miles. The age schedule is from three to six years, averages four years.

Pickups are traded in between 50,000 and 75,000 miles or every two to three years.

The mileage range on **passenger cars** is wider, from 30,000 to 125,000 miles; however, the average mileage range is about like trucks, 60,000 to 80,000 miles. Those who use age as the determining factor operate them for three to four years.

Trucks and passenger cars, of course, exceed any other single item of equipment in regard to the number of units in use. For passenger cars, there is one unit for every 55 miles of pipeline. Of these, 89.4% are owned and 10.6% leased.

Body styles are: *Two-door sedans,* 34.8%; *four-door sedans,* 50.9%; and *station wagons,* 13.3%. A small number are compact two and four-door sedans and station wagons.

Although more trucks are leased than passenger cars percentage-wise, ownership is still far in the forefront. One truck unit is required per 50 miles of pipeline; 84.7% are owned and 15.2% are leased. Gross vehicle weights for trucks are:

0 to 10,000 lb	81.2%
10,000 to 19,500 lb	13.1%
19,500-lb and over	5.7%

Body styles are: *Pickups,* 62.6%; *flat-beds and/or stake bodies,* 16.3%; *vehicles with service bodies,* 8.4%; with *crew bodies,* 5.8%; *and highway tractor units,* 3.4%. The remaining 3.5% consists of *panel trucks, Jeeps,* and *dump trucks* in limited numbers.

Semi-trailers owned consist of 53.8% pipe and pole; 22.1% low-boy; 19% flat-bed; 2.5% van; and 2.5% office-type.

Miscellaneous Equipment

The list of construction-maintenance equipment is extensive and also includes these miscellaneous items:

Electronic pipe locators.
Holiday detectors.
Pearson-type holiday detectors.
Dope kettles.
Blowers.
Pipe tapping and plugging machines.
Road boring equipment.
Portable electric tools. These consist of drills, impact wrenches, hand saws, grinders, buffers, sanders, etc.

DESIGN DETAILS OF ALBERTA-CALIFORNIA LINE UNFOLDING

FRANK H. LOVE, *Editor*

AS CONSTRUCTION of the Alberta-California pipeline system that will bring Canadian gas to the San Francisco Bay area and parts of the Pacific Northwest gets underway, many of the design details are unfolding. Although some of the so-called innovations are not new basically, they are in the extent of their application to this project. It is observed, for example, that most of the 1368 miles of main line extending from Alberta into northern California will be coated internally with epoxy resin, that 296 miles of overland main line will be coated externally with Somastic, that, except in Alberta, there will be no trench-side coating of pipe, and that most of the half million tons of pipe will be double-jointed and coated in central yards prior to stringing.

Another noteworthy aspect is the speed with which the extensive system will be constructed. Scheduled operating date is early November. Officially, work began October 17. An unusually mild winter along much of the line permitted faster work than anticipated, but it will be summer before a high-speed program can be attained. Meanwhile, right-of-way is being cleared and graded, pipe strung, internal and external coatings applied, pipe double-jointed, some river crossings made, and

Route of the Alberta-California gas pipeline system.

First weld on the system was made October 18, 1960 . . . this was in Alberta about 15 miles west of Calgary.

about 60 miles (as of March 1) of pipe laid. Winter is helping in one respect, however . . . considerable terrain in Alberta is muskeg, which is much easier to work on when frozen.

Customarily, Somastic coating is used in river crossings, offshore lines, and swamplands, to provide maximum protection to the pipe and to add weight. Its use on all the overland main line in California was prompted by rocky terrain throughout a large part of the route and the fact that the contractor's bid on this type of coating was sufficiently attractive to cause its adoption by the owner company, Pacific Gas and Electric.

H. C. Price Company, who is applying the coating as well as laying the California section of the system, is now operating a plant at Burney, California. Later the scene of operations will be moved to Napa, California, near the Kaiser Steel plant, which is providing the major portion of the line pipe for the California construction.

A ⅝-in. thickness of coating is being applied, adding 66.7 lb per ft to the pipe. Coating and pipe, which predominantly has a 0.438-in. wall, weigh 166 lb per ft. Thus, an 80-ft double-jointed length of pipe weighs 18,500 lb and stringers can load only two lengths to a truck.

Internal application of epoxy resin along much of the system (Alberta Trunkline excepted) represents the first time this has been done during initial construction of a project of this magnitude. Use of epoxies is but a few years old. A number of gas pipelines have experimented with its capability to reduce friction factor and mitigate corrosion. These tests have been on sections of pipeline systems already in use, Transcontinental Gas Pipe Line having done more of this experimenting than any other, with reported good results. In the case of the Alberta-California pipeline, the epoxy resin is primarily to lessen friction but it also will help with a hydrogen sulfide problem. Gas from the Alberta fields, where the supply originates, is extremely high in H_2S content, some as great as 70%. The initial point of solution to the problem will be in the various producing fields where treating plants will be installed to remove liquids and eliminate most of the hydrogen sulfide. However, it is always possible that there might be processing plant malfunctions, in which case there could be periodic hydrogen sulfide carryover into the pipeline system. In this event the carryover would be mitigated by the epoxy resin coating.

Epoxy resin is being applied to the inside of the pipe to a thickness of 0.002 in. Application is at the pipe mills — the Provo, Utah, plant of Consolidated Western, the Napa, California, plant of Kaiser Steel, and the Welland, Ontario, mill of Welland Tubes Limited—as well as at some of the field yards in Oregon where pipe is double-jointed.

Section of double-jointed pipe emerges from Somastic-coating machine. Rig at right, which will lift the pipe, has a wide bearing surface in order not to damage the coating.

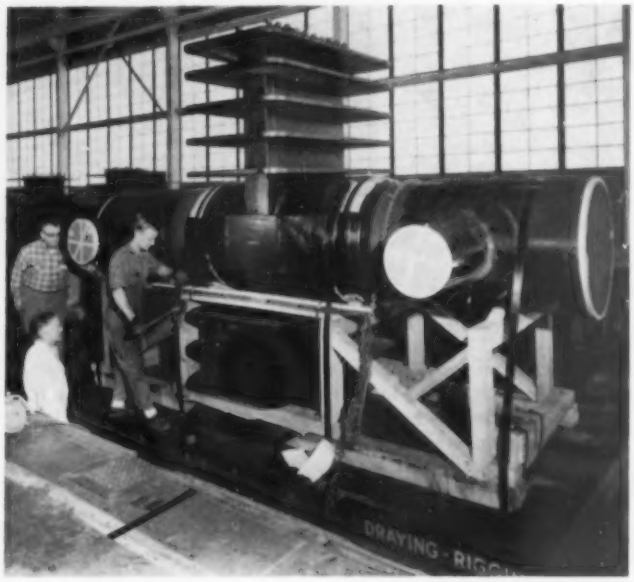
The pipe yards are at Elwood and Winona, Washington; Sprague River, Gilchrist, Madras, Condon, and Hinkle, Oregon; Sandpoint and Hauser, Idaho; and Lundbreck, Nanton, Black Diamond, Codner, Cremona, Jumping Pound, Lodgepole, Rocky Mountain House, Cynthia, and Peers in Alberta.

Some of the above yards also will be used as sites for external coating and wrapping of pipe. The policy of yard coating all pipe was adopted as a means of obtaining a more uniform coating than thought possible in the field, overriding in the minds of the designers any disadvantage that could accrue from damage in transit between yard location and right-of-way. The coating program for the main line other than in California calls for a flood coating of asphalt enamel, a glass fiber inner wrap and a rag felt outer wrap.

This much-publicized pipeline system, which first had to be cleared by the National Energy Board of Canada, The Dominion government of Canada, the Alberta Oil and Gas Conservation Board, the Province of Alberta, the U. S. Federal Power Commission, and the California Public Utilities Commission, is a joint undertaking of the Pacific Gas and Electric Company, Pacific Gas Transmission Company, Alberta Natural Gas Company, The Alberta Gas Trunk Line Company, and Alberta and Southern Gas Company. Alberta and Southern primarily is a gas purchaser for its owner company, PG&E. The Alberta Gas Trunk Line Company will function as a contract carrier from the gas fields to the Alberta-District Columbia border. The other three also will operate as transmission companies. Areas of operations are shown on the accompanying map.

Several other companies are associated with the Alberta-California project. Canadian-Montana Pipe Line Company (subsidiary of The Montana Power Company) will purchase a small amount of gas from Alberta and Southern at a point on the Alberta Gas Trunk Line system just north of the Alberta-Montana boundary and sell it to its parent company. Westcoast Transmission Company will purchase gas from Alberta producers for resale to El Paso Natural Gas Company at the international boundary near Kingsgate, British Columbia, the gas being transported within Alberta by Alberta Gas Trunk Line and through British Columbia by Alberta Natural. El Paso Natural Gas Company, sole supplier of natural gas to distributing companies in the Pacific Northwest and the principal supplier to California distributing companies, will ship gas through the Alberta-California facility to various delivery points in Idaho, Washington, and Oregon.

Peter Many Wounds and his crew clearing right-of-way through their reservation — the Sarcee Indian Reservation in Alberta.



One of the specially-made 36-in. main line gate valves being readied for shipment from the Grove plant in Oakland. Each valve weighs 28,000 lb and will be approximately 20 ft high when the control mechanism is installed at the jobsite.

Engineering-management services are being provided individual clients who will operate the various sections of the pipeline from Alberta producing fields to the California-Oregon border by Bechtel Corporation in the United States and Canadian Bechtel Limited in Canada. Pacific Gas and Electric is supervising construction of the California portion of the project.

Route of Line

Originating in the eastern foothills of the Rocky Mountains, approximately 150 miles west-northwest of Edmonton, Alberta, the line runs south through western Alberta, crosses the southeastern corner of British Columbia, passes through the Idaho Panhandle and the southeastern corner of Washington, extends completely through the state of Oregon, and into northern California, terminating at Antioch in the San Francisco Bay area.

Throughout this route many types of terrain are encountered . . . mountains, forests, canyons, deserts, rangeland, farmland, lava beds, and numerous rivers. Temperatures along the route have been recorded as high as 117 F and as low as minus 50 F in the winter, and altitudes range from 6600 ft to sea level.

Of the system's 1368 miles of main line, 910 miles are in the United States and 458 miles in Canada. All but 125 miles at the extreme north end of the line in Alberta are 36-in. pipe; this northern-most section is 30-in. pipe.

One of the greatest natural obstacles on the U. S. portion of the line is lava rock. In California, particularly, solution to the ditching problem has been found in equipping backhoes with heavier buckets than normally would be the case—1-yd buckets replacing the ¾-yd buckets—equipping ditchers with 21-ft wheels, and liberal "shooting." Shot holes are spaced on a 30-in. staggered plan, in effect providing a charge every 15 in. PG&E is using TNT in flake form, a quantity of which was purchased as army surplus. It is anticipated, too, that considerable "shooting rock" will be encountered on the Canadian portion of the system, particularly in crossing the Rocky Mountains in British Columbia. In fact, Crowsnest Pass, the Continental Divide between Alberta and British Columbia, will be a key point of interest because of its rocky nature. Another will be the Moyie River Valley of British Columbia and Idaho where the Moyie will be crossed 11 times in a distance of 13 miles.

In various areas throughout the system heavy timber is another important factor. The extent is indicated by the situation in California alone where it is estimated from 2,000,000 to 3,000,000 board ft of merchantable timber will be taken from the right-of-way.

River Crossings

Numerous major and minor river crossings are being made during the course of construction. Major crossings are by special contract. Minor crossings are being installed by main line contractors as a part of their overall contract.

Most crossings are single 36-in., .531-in. wall buried lines. All major crossings are coated with ⅝-in. of Somastic plus 3 to 5 inches of concrete, enough to provide 10% negative buoyancy to the pipe. All underwater lines are being pulled. Here are the specifics for some of the more important crossings.

An interesting installation to watch will take place at the extreme northeast arm of San Francisco Bay, where an overall crossing 4½ miles in length will be made of the Sacramento River, Sherman Island, and the San Joaquin River, the island lying at the juncture of the two rivers at this point. The crossing will be dual 26-in., .500-in. wall lines protected and weighted with a coating consisting of ⅝ in. Somastic and not less than 2¼ in. concrete. The rivers are navigable and a 6-ft cover will be required, both for this reason and the fact that the tide is especially strong. This will put the lines 44 ft below mean low tide. The contract for the crossing has not been let.

Farther north, at Red Bluff, California, the Sacramento River will again be crossed with dual 26-in. lines. This will be a 1700-ft crossing with pipe specification and coating identical with the one just discussed.

Deviations from the general procedure of burying river crossings will

Double-ending plant in operation. Here two lengths of 36-in., 40-ft pipe are brought together for automatic welding into one length.

be Battle Creek and Pit River. The former, a tributary of the Sacramento River about 31 miles northeast of Red Bluff, is a rather shallow stream but it flows through steep rock canyon, consisting of 36-in., .625-in. wall bare pipe. The distance will be about the same as the depth—140 ft. It will be necessary to cut down into the banks 20 ft on either side to obtain the proper bench.

To cross Pit River, near Burney, California, 36-in. diam, .625-in. wall pipe will be carried on existing piling of an abandoned bridge. There are now three bents and another will be added. Each of the bents will be equipped with rollers, upon which the pipe will rest. This will be a 440-ft crossing.

Other than the instances discussed all river crossings will be single 36-in. buried lines. A short 200-ft crossing will be made of the Fall River, also near Burney.

Snake River will be crossed near Starbuck, Washington. The crossing is 1700 ft wide, has steep embankments and railroad tracks on both sides. The river bed is solid rock for the most part.

The Pend Oreille River is being crossed at a point 2300-ft wide southwest of Sandpoint, Idaho, where the river is 80 ft deep.

The Kootenai River, in Idaho, already pulled, required a 1000-ft crossing near Bonners Ferry, about 22 pipeline miles south of the Canadian-U. S. border. Somastic will be applied to a thickness of ⅞ in. and concrete to a thickness of 3 to 5 in.

Minor river crossings, which are a part of the main line contracts, are 36-in. by .531 or .438-in. wall buried lines, but with a double coat of asphalt enamel, an inner wrap of glass, and a felt outer wrap, weighted either by use of gunnite or river weights.

Compressor Station Plans

Three compressor stations are contemplated on the U. S. portion of the system for the initial phase of operation. One 5000-hp unit will be installed at Martindale, near Sandpoint, Idaho; two 5000-hp units at Wallula, near Walla Walla, Washington; and two 5000-hp units at Diamond Lake Junction, south of Bend, Oregon. In British Columbia, a 14,000-hp station will be built near Crowsnest.

Future stations, as now planned, will be at Eastport and Athol, Idaho; Rosalia and Fields Gulch, Washington; Ione, Wilcox, Lamonta, Paulina Prairie, and Lost River, Oregon.

Under the export-import authorizations an average daily volume of 606,000,000 cu ft of gas can be brought into the United States. Of this volume, 415,000,000 cu ft will reach Pacific Gas and Electric for distribution in northern California, 152,000,000 cu ft will go to El Paso Natural, and 30,000,000 cu ft to Montana Power.

Pipe Specifications

The 36-in. main line pipe is grade API 5LX-52, having a specified minimum yield of 52,000 psi. Wall thickness is 0.438 in. This pipe has a maximum operating allowable of 911 psi, and will be field tested to provide a generous safety margin. Other pipe, installed to meet specific conditions, will have wall thicknesses of 0.453, 0.469, 0.500, 0.531, 0.563, 0.625, and 0.656 in.

Communications

A microwave communications system will be installed on the U. S. portion for operation of the line. In Canada it is required that government communications facilities be employed.

Contractors

Contracts awarded to date include the following:

H. C. Price Co.—291 miles of main line from San Francisco Bay, California, to California-Oregon border; and 146 miles of main line from Rosalia, Washington, to Idaho-British Columbia border. Also Somastic coating of the California section.

Western Pipe Line, Inc., and J. P. Neill and Co.—joint venture—468 miles of main line from California-Oregon border to Rosalia, Washington.

Majestic Contractors, Inc. — 113 miles of main line from the Alberta-British Columbia border to Priddis, Alberta; 63 miles of main line from Rocky Mountain House, Alberta to a point west of Cynthia; and 38 miles of 22-in. lateral from Rocky Mountain House to the Homeglen-Rimbey gas field.

Alberta Consolidated Pipe Line Builders (joint venture of Mannix Company, Ltd., Piggott Construction, Ltd., Banister Construction Company, Ltd., and Marine Pipeline and Dredging, Ltd.)—113 miles of main line from Priddis to point near Rocky Mountain House; and 64 miles of 16-in. delivery lateral from Blairmore, Alberta, to Carway, Alberta, near the Montana border.

Dutton-Williams Brothers, Ltd.—62 miles of main line from West Cynthia to a point west of Whitecourt and 20 miles of 22-in. lateral from there to the Whitecourt field.

Price-Poole of Canada, Ltd. (joint venture of H. C. Price of Canada and Poole Construction Company) — 107 miles from Crowsnest Pass, British Columbia, to Idaho border at Kingsgate-Eastport.

River Construction Company — Kootenai and Pend Oreille river crossings.

Missouri Valley Dredging Company —Snake River crossing.

Stanley-Bledsoe Corp. — double-jointing, yard-wrapping, and internal coating.

L. C. Russell Co.—Internal coating.

R. F. Walsh Co.—Internal coating.

Dunn Bros.—Pipe stringing.

Parkhill Truck Co.—Pipe stringing.

Bigge Drayage Company — Pipe stringing.

Motorola Communications and Electronics, Inc. — Microwave radio communications system in U. S. Sections.

Canadian Ingersoll Rand—14,000 horsepower gas-fueled compressor engine for Alberta Natural Gas Company in British Columbia. ★ ★ ★

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SOMASTIC® protects best against costly pipeline corrosion

Field performance of pipeline coatings can be conclusive only when pipelines that have been in operation for a number of years, and that are of substantial length, are examined for flaws and breaks in an otherwise continuous line. Results of such field examinations of SOMASTIC® coated pipelines, under varying soil and moisture conditions, are available. (See coupon.)

These tests prove conclusively that SOMASTIC® coating gives *maximum* protection against corrosion under the most adverse soil and moisture conditions. The result is longer line life, plus substantially lower maintenance and repair investments.

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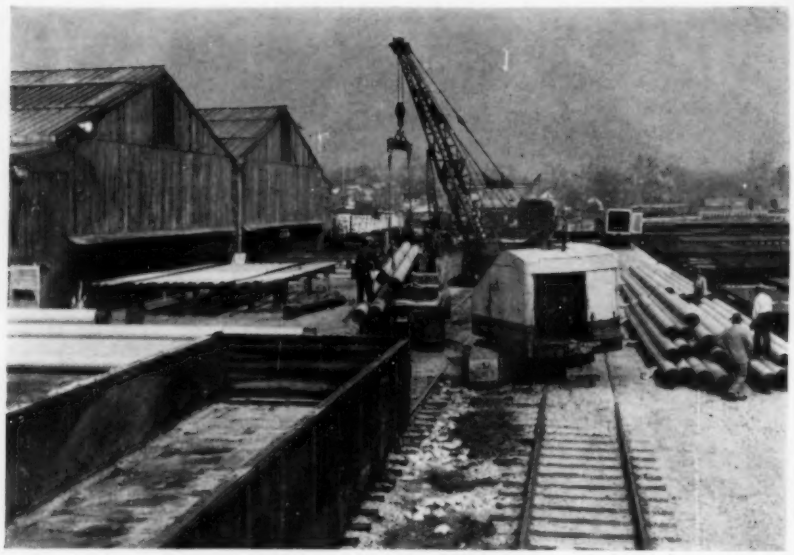

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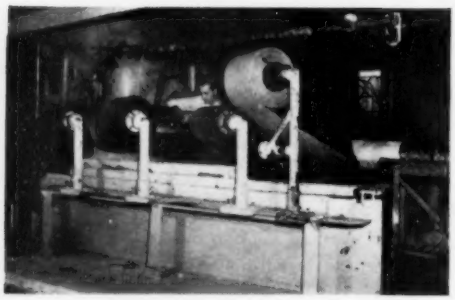
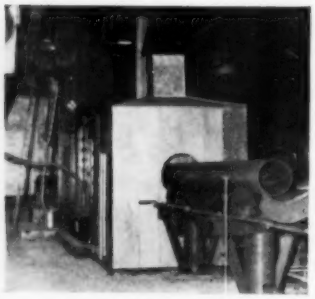
Control board of schedules in Plant Office

Skilled workmen throughout the plant of Standard Pipeprotection Inc. see to it that your pipe is coated and wrapped precisely according to your specifications. Adequate control of every step of processing results in your pipe starting to its destination exactly on schedule.



Coating and wrapping machine



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Standard, Pembina Join Forces To Boost Westalta Project

Standard Oil Company (Indiana) and Pembina Pipe Line, Ltd., have agreed to collaborate on the design, finance, construction, and operation of the project proposed by the Pembina subsidiary, Westalta Products Pipe Line, Ltd., to move excess wet gas liquids from Alberta, Canada, to Chicago.

Tuloma Gas Products Company, a wholly-owned subsidiary of Standard, is offering to purchase natural gas liquids from Alberta producers on a 20-year basis.

The entire project is contingent upon approval of applications now pending.

FPC Okays Two "Budgets"

Budget-type construction proposals by Arkansas Louisiana Gas Company and Columbia Gulf Transmission Company have received Federal Power Commission authorization.

Arkansas Louisiana during 1961 will construct facilities costing not more than $6,918,500, with the cost of single projects limited to $500,000.

Columbia Gulf will construct during 1961 facilities that will not exceed a $1,500,000 total, with each project limited to $500,000.

FPC FILINGS

Recent Applications For Gas Line Construction

Cities Service Gas Co., Oklahoma City, Oklahoma, CP 61-196, filed January 23, 1961.

Construction: Looping approximately 8.5 miles of existing 12-in. in Franklin County, Kansas, with 20-in. replacing 8 miles of 10-in. with 16-in. in Jasper County, Missouri; replacing 5 miles of 4-in. line with 8-in. in Newton County, Missouri; and replacing 2.5 miles near Saginaw station, Newton County, Missouri, with new 16-in. pipe.

Cost: $1,169,000 for construction, of which $567,600 is the cost of materials, $24,000 the cost of labor, and $430,500 the cost of contract work. Salvage totals $67,000.

PIPELINING

- ***Owner Company Reports***

East Tennessee Natural Gas Co., Knoxville, Tennessee, CP 61-199 and CP 61-200, filed January 24, 1961.

Construction: 14.5 miles of 6-in. by 0.188 lateral pipeline from existing 8-in. Johnson City-Elizabethton lateral to a point near Unicoi, Tennessee, plus necessary regulating and measuring facilities, to deliver to Volunteer Natural Gas Company and possibly the Unicoi County Utility District (which would build own distribution lines after assurance of service). Also, an 11.43-mile, 8-in. by 0.188 lateral from existing 16-in. line, six miles south of Tri-Cities Junction, to serve American-Saint Gobain Corporation's Greenland glass plant in Hawkins County, Tenneesee; and a 5.3-mile, 6-in. by 0.188 extension from this lateral to Surgoinsville, Tennessee, plus measuring and regulating equipment, to serve Natural Gas Utility District of Hawkins County.

Costs: The 14.5, 6-in. lateral to serve Volunteer would cost approximately $381,010, which would include $168,669 for materials and $147,511 contract cost. The 11.43-mile, 8-in. lateral to serve American-Saint Gobain and the 5.3-mile, 6-in. extension to Surgoinsville would cost $596,369, of which $231,419 would cover materials and $278,707 contract cost.

El Paso Natural Gas Co., El Paso, Texas, CP 61-202, filed January 25, 1961.

Construction: 37.4 miles of 8 in. by 0.188 lateral pipeline from main line to a termination point 22.6 miles north of Southwest Forest Industries' pulp paper plant near Snowflake, Arizona, from which point Southern Union Gas Company will build the remainder of the line to serve the plant.

Cost: $949,000 for El Paso's 37.4 miles, of which $331,700 is cost of pipe, $8800 is cost of valve assembly, $15,100 for clearing, $11,900 for unloading, hauling, and stringing, $127,700 for ditching (30% hard rock), $9600 for bending, $61,500 for lineup and welding, $78,200 for cleaning, priming, painting, and wrapping, $6900 for lowering in, and $19,300 for backfilling and cleanup. Labor totals, $186,520.

SUPERIOR PROTECTION with Protecto Wrap quick-drying 160 MASTIC

Protecto Wrap 160 Mastic is a thick, heavy-bodied, solvent release, cold applied solution coating, formulated specifically for use underground as a protective coating for steel pipe, tanks, and similar equipment. It is a refined coal tar product containing inert mineral filler, synthetic resin and solvent giving this mastic the highest possible wetting and penetrating action obtainable.

Protecto Wrap 160 Mastic requires no primer, no thinner and no stirring, and will not irritate workman's skin. It may be applied by any of the conventional methods. It touch dries in approximately 45 minutes. If desired, a second coat may be applied within four hours. It is available in 55 gallon drums, 5 gallon pails and 1 gallon cans.

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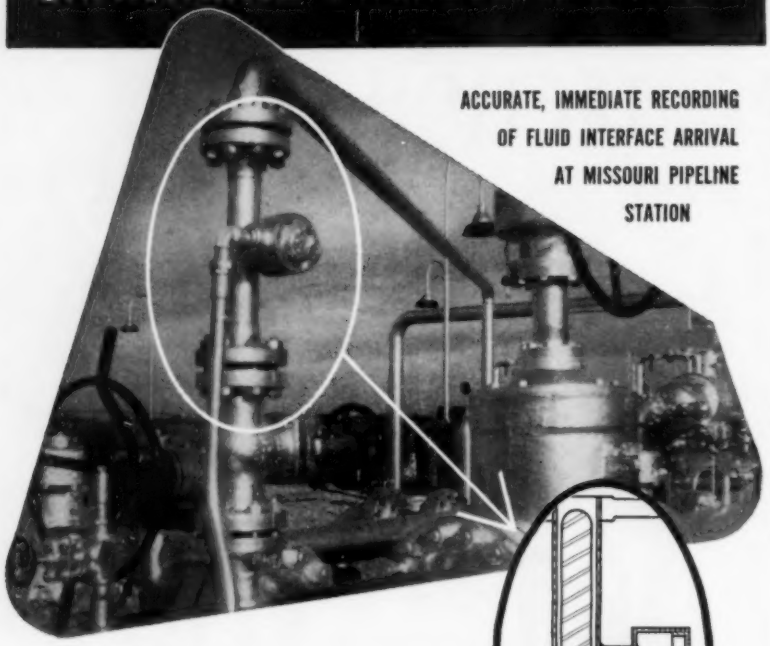

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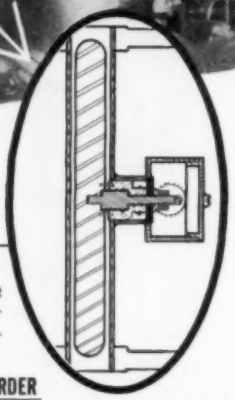
Plastic coated. Cable connection inside explosion-proof conduit.



◀ MODEL DLRE RECORDER

For local recording with weather-proof housing. Connected by coaxial cable and located over 200′ from probe.

CPA measures and records interface, water content or component changes in the fluid stream by measuring dielectric differences of fluid passing through a probe. Recording is on 12″ round chart.

SPECIFICATIONS

Range of Measurement: 4.3 MMFD minimum and 1100 MMFD maximum (equal to 1% min. and 35% max. for water in oil)
Accuracy: Within 0.5 of 1% of actual capacitance indicated (equal to ± 0.15 of 1% water in oil)
Sensitivity: Standard — 0.043 MMFD equivalent to 0.01 of 1% water contamination in oil
Power: 115 volt, 60 cy. A.C.
Recorder Motor: Electric or spring wound
Recording: Local — at or near point of measurement; Telemetering — over any pair of telegraph grade wires; Pneumatic — provides air signal at distant point
Housing: Explosion-proof or weather-proof
Optional Accessories: High-low alarm switches; 7-day or 30-day recording charts; Temperature compensation
Probes: 2″, 3″ and 4″ flanged, grooved or threaded

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PIONEERS IN LEVEL MEASUREMENT AND CONTROL INSTRUMENTATION

New York State Natural Gas Corp., Pittsburgh, Pennsylvania, CP 61-198, filed January 23, 1961.

Construction: Compressor, measuring, and regulating stations to provide storage service for Transcontinental Gas Pipe Line Corporation near Tamarack, New York. Starting April 1, 1961, facilities would provide for a maximum of 3,750,000 cu ft to be injected.

Cost: $1,181,100. The 2000-hp compressor station includes: 32 by 40 ft building, $7000; gas engine compressor, $260,000; dehydration plant, $235,000; gas cooler, fin fan, $29,000; electrical equipment, $20,000; miscellaneous auxiliary piping and equipment, $30,000; gas piping, hand and processing equipment, $250,000; foundations, $20,000; construction supervision and labor, $200,000; engineering and inspection, $15,000; trucking and freight, $15,000; administration overhead, $20,000; and contingencies, $37,000; totaling, $1,138,000. The measuring and regulating station includes $35,600 for materials, $7000 for labor, plus $500 for miscellaneous, totaling $43,100.

Texas Eastern Transmission Corp., Houston, Texas, CP 61-203, filed January 26, 1961.

Construction: 330 miles of pipeline from Louisiana to Mississippi to New Jersey; plus a 7500-hp compressor station at West Monroe, Louisiana, and these horsepower additions to existing stations (12,500 at Kosciusko, Mississippi; 15,000 at Gladeville, Tennessee; 16,000 at Danville, Kentucky; in Ohio, 15,000 at Wheelersburg and Berne, respectively, 2050 at Lebanon, and 2000 at Circleville; and in Pennsylvania, 10,500 at Delmont and 1750 at Wind Ridge); plus the changing of impellers in existing compressors at various stations and installation of various meter and regulating stations in connection with the expansion program, the objective of which is to provide 225,000 Mcf additional daily capacity.

Cost: $84,521,000 total, of which $53,945,000 covers pipeline, compressor and meter stations to be built prior to November 1, 1961. Of the pipeline costs: $13,562,000 covers 165 miles of 20-in.; $4,082,000, river crossings; $17,967,000 for 127.8 miles of 30-in.; $3,685,000 for 26 miles of 12 and 14-in.; and $1,429,000 for 11 miles of 10-in.

Transcontinental Gas Pipe Line Corp., Houston, Texas, CP 61-194, filed January 23, 1961.

Construction: 162.70 miles of 36-in. main line loops in Louisiana, Mississippi, Alabama, Georgia, South Carolina, North Carolina, Virginia, and

Maryland. Other facilities: 2500 additional horsepower at station No. 30, Wharton County, Texas, and 2500 hp addition at station No. 130, Madison County, Georgia; a new compressor station (No. 505) of 6000 hp, Somerset City, New Jersey, plus dwellings; a new meter station (New York State Natural-Leidy meter and regulator station), Clinton City, Pennsylvania; and sales facilities, Union County, New Jersey.

Total Cost: $30,000,000.

Loop Materials and Costs. Line pipe: approximately $13,671,073. This includes 60,400 ft of 36-in. by 0.469; 801,104 ft of 36-in. by 0.406; and 1320 ft of 36-in. by 0.500. Coating: approximately $2,141,801. Installation: an estimated $5,764,636. Right-of-way and damages: $797,479. Engineering and supervision: $410,132. Total: $22,785,121.

Station Materials and Costs. No. 30: materials, $438,300; installation, $205,200. No. 130: materials, $374,700; installation, $175,300. No. 505: materials, $1,665,800; installation, $764,900. Meter and regulator station: materials, $56,700; installation, $14,500. Distribution meter and regulator station: materials, $26,000; installation, $15,500. Total: $3,736,900.

Dwelling Materials and Costs. Two units complete with service system: $7,088 each for materials and $19,912 each for installation; plus field engineering totaling $2700. Total: $56,700.

SEC REPORT

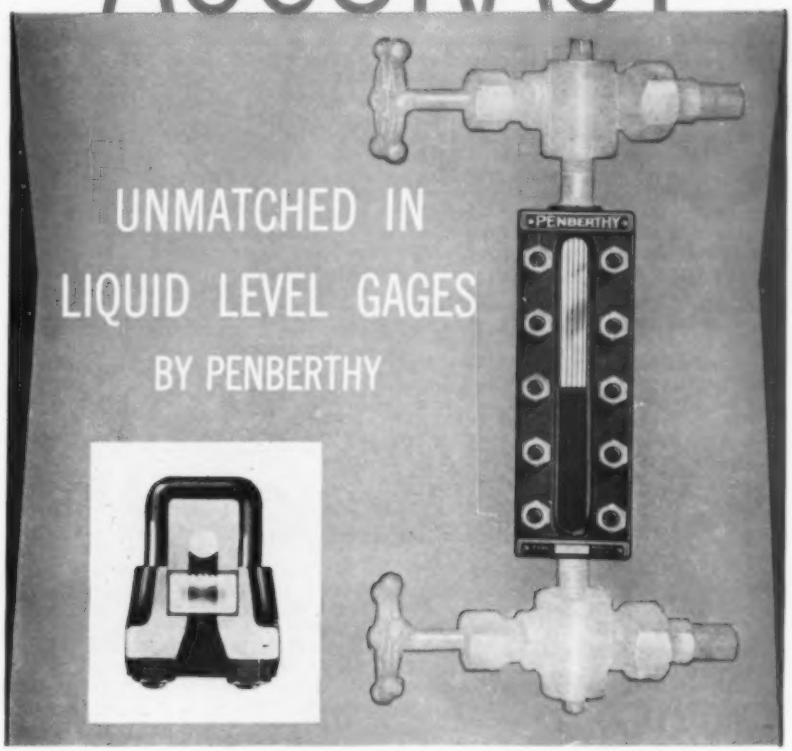
Notes From News Digest

Lone Star Corporation. Lone Star Gas Company has filed registration of 665,838 shares of common stock, net proceeds of which will be used to prepay without premium existing short-term bank borrowing and to provide a portion of funds needed to finance a 1961 construction program presently estimated at $33,700,000 — of which about $10,000,000 will be spent for transmission, gathering, and compression facilities. It is estimated that about $10,000,000 will be required from external sources for the 1961 construction program.

Buckeye To Extend To Bay City

Construction of 42 miles of 8-in. products pipeline from Flint to Bay City, Michigan, at a cost of $1,700,000, is being planned by The Buckeye Pipe Line Company.

ACCURACY



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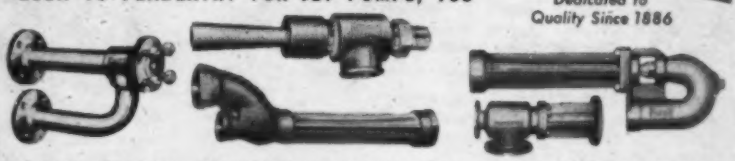

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PIPELINE CONTRACTORS

● **Alberta Consolidated Pipe Line Builders.**
Alberta Gas Trunk Line Company, Ltd.—113 miles of 36-in. from Priddis, Alberta, to a point near Rocky Mountain House, and 64 miles of 16-in. from the main line near Waterton Park gas field to the Montana border near Carway. Alberta Consolidated is a joint venture of Mannix Company, Ltd., and Piggott Construction, Ltd., both of Calgary, Banister Construction Company, Ltd., Edmonton, and Marine Pipeline and Dredging, Ltd., Vancouver.

● **Banister Construction Co. Ltd., 625 Northern Hardware Bldg., Edmonton, Alberta, Canada.**
Trans-Prairie Pipe Lines Ltd.—160-mile crude oil system in northeastern British Columbia, as follows: 40 miles of 4-in., Taylor to Dawson Creek; 30 miles of 6-in., Boundary Lake to Taylor; 75 miles of 8-in., Taylor to Milligan Creek field; 11 miles of 4-in., Milligan Creek to West Beaton field; 2 miles of 8-in., Taylor station to tank car loading rack; and 2 miles of 4-in., Taylor station to McMahon refinery. Crews are presently laying 8-in. pipe, under the supervision of Bill Bartlett.

● **O. R. Burden Construction Corp., Box 5216, Tulsa, Oklahoma.**
Alamo Gas Supply Co.—291 miles of 14 through 24-in. in southwest Texas to supply gas to San Antonio, Texas.

● **Canadian-Parkhill Pipe Stringing Ltd., 164 Eglinton Ave., E., Toronto, Ontario, Canada.**
Alberta Gas Trunk Line Co., Ltd.—under subcontract from Dutton-Williams Bros., 20 miles of 22-in. and 62 miles of 30-in. from Windfall to Lovett River; under subcontract from Majestic Contractors Ltd., 63 miles of 30-in. and 38 miles of 22-in. from Lovett River to Rocky Mt. House, and 113 miles of 36-in. from west of Calgary to the British Columbia border; and under subcontract from Piggott Construction Ltd., 64 miles of 16-in. from the southend lateral to the Montana border. Field office: Calgary. Curtis Williams is general superintendent, Wes Strangh is office manager.

● **Cape Construction Co., Box 423, Cape Girardeau, Missouri.**
Trunkline Gas Co.—a 30-in. line from a point 8 miles north of Effingham, Illinois, to Neoga, Illinois, Cumberland County. Headquarters: Effingham. Superintendents: G. L. Mims and Ira Sugg.
Mississippi River Transmission Corp.—a 91-mile, 18-in. natural gas pipeline from near Johnsonville, Illinois, in Clay County, to St. Louis County (north of St. Louis, Missouri, where one field office is located), including dual 12-in. crossings of the Mississippi River. Other field offices: Breese and Salem, Illinois. Superintendents: R. C. Whitworth, G. L. Mims, and Trece Boyd.

● **Dutton-Williams Brothers, Ltd., North Canadian Oil Building, Calgary, Canada.**
Alberta Gas Trunk Line Company, Ltd.—62 miles of 30-in. from West Cynthia to West Whitecourt, Alberta, and 20 miles of 22-in. lateral from this main line to the Whitecourt field. Harland Evens is project manager.

● **Ford, Bacon & Davis Construction Corp., Box 1762, Monroe, Louisiana.**
American Louisiana Pipe Line Co.—24 miles of 24-in. pipeline from Krotz Springs to Latell, Louisiana. Headquarters: Opelousas. Superintendent: F. A. Phillips.

● **R. H. Fulton & Co., Box 1526, Lubbock, Texas.**
Continental Pipe Line Co.—550 miles of 2, 3, 4, 6, and 8-in. in Montana and Wyoming.

● **Golightly Construction Corp., Box 15152, Houston, Texas.**
Pan American Pipe Line Co.—32-mile, 12-in. pipeline between Texas City and Pasadena, Texas. Headquarters: South Houston. Spreadman: Clarence Null. Office manager: D. L. Burtram.

● **Grayco Constructors, Inc., Box 4147, Austin, Texas.**
Trunkline Gas Co.—approximately 20 miles of 30-in. from near Senatobia, Mississippi, southwest to near Ballontine, Mississippi. Emmett E. Wilkerson will supervise.

● **H & K Construction Co., S. San Patricio, Sinton, Texas.**
Seadrift Pipeline Co.—80-mile dual 6-in. LPG line as joint venture with Roy Vickers Lease Service starting at Markham and ending at Baytown, Texas.

CROSE

NEW ROAD BORING MACHINE

CENTER SEAT FOR OPERATOR — Sitting in seat located directly over center of machine, operator can keep casing lined up perfectly with hole being bored.

REVERSE-O-MATIC TRANSMISSION — With this new type transmission, operator can switch auger from forward to reverse without engine slowdown. No gear shifting.

HEAVY DUTY TORQUE CONVERTER — For full, constant speed and smooth power flow, eliminating up to 90% of shock load imposed on drive train.

The new Crose Road Boring Machine provides the fastest, simplest, most economical way for boring crossings and installing casings up to and including 42" in diameter. Heavy duty torque converter and reverse-o-matic transmission deliver full, constant speed and smooth power flow . . . let you switch auger from forward to reverse without engine slowdown . . . no gear shifting.

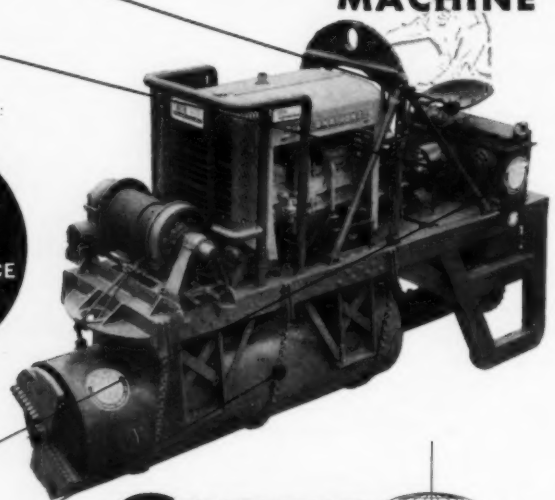
The smaller Model RBA Crose Road Boring Machine is still available for casing up to 24".

WRITE CROSE TODAY FOR COMPLETE INFORMATION

NEW GEAR AND CHAIN BOX — With pressure lubrication feature — has been added to the new Crose Road Boring Machine for greater power capacity.

CASING CLAMP BANDS ELIMINATED — Instead, you use adjustable casing chains which can be easily installed or removed when machine is in ditch.

FIELD-TESTED TOP PERFORMANCE



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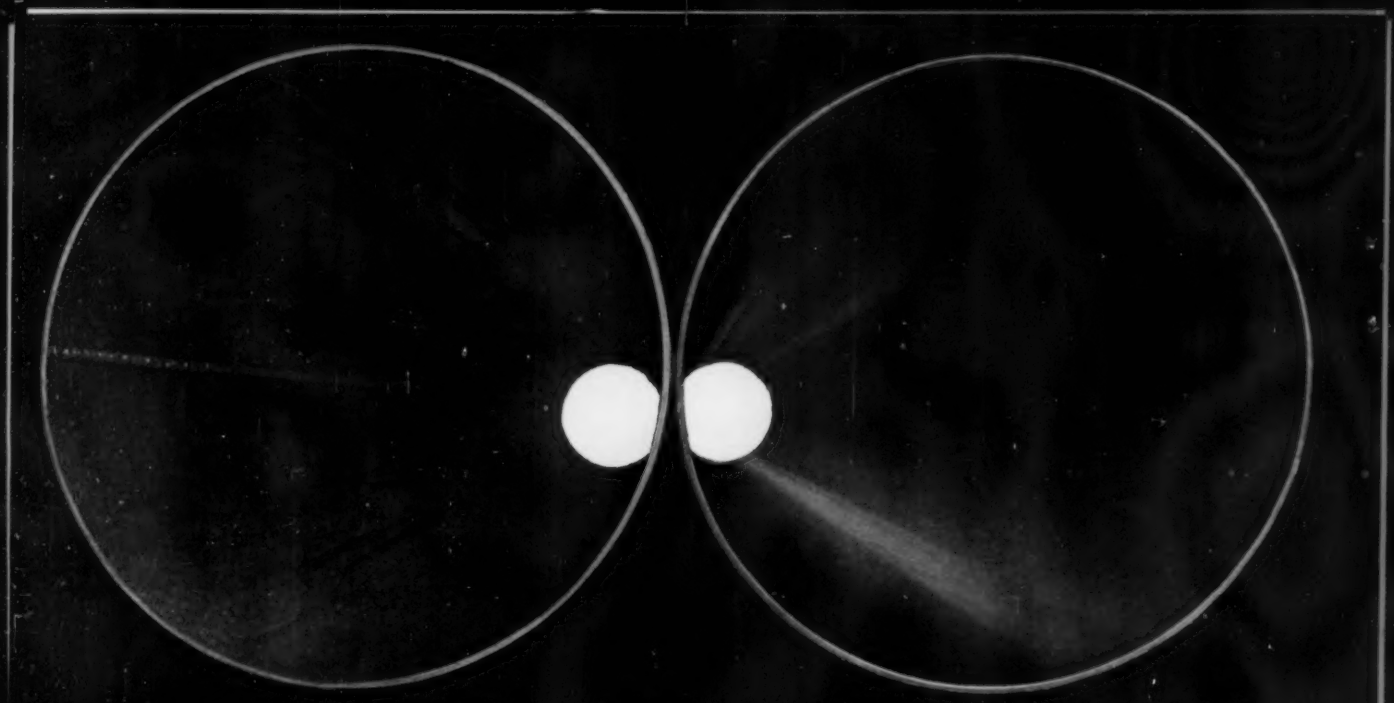

At the right above is one section of a 30" line pipe internally coated with Napko's Epoxycote Pipeliner, the first amine-cured epoxy resin specifically formulated for gas line transmission. Epoxycote Pipeliner has now been used in all parts of the country with equally good results, providing a surface smoothness that increases line-flow efficiency and reduces maintenance costs. The uncoated section at the left shows severe pitting that can occur during transit and storage and that can be prevented by Epoxycote Pipeliner.

6% INCREASE IN PIPELINE FLOW EFFICIENCY WITH NAPKO EPOXYCOTE PIPELINER!

Extra Thru-Put and Cleaner Gas at Lower Maintenance Cost

Throughout the United States pipeline engineers report that lines internally coated with Napko's Epoxycote Pipeliner show record improvement in thru-put, product purity, and line maintenance economy.

Studies indicate that the walls of coated pipe have an average relative roughness of 280 micro-inches, compared to an average of 700 micro-inches in unweathered mill pipe. Weathered pipe in a mild environment in as little as 60 days can attain a surface roughness up to 1500 micro-inches (an additional 2-5% loss in efficiency).

Leading internal coating specialists such as L. C. Russell Company, Rosson Richards Company, H. C. Price Company and Stanley-Bledsoe Corporation testify to the dependable behavior of Epoxycote in both application and finished film properties.

For complete details and published project references write to

TESTED FEATURES OF EPOXYCOTE PIPELINER

PREVENTS PITTING IN TRANSIT & STORAGE: In industrial atmospheres, humid regions, and particularly marine areas, severe pitting can occur in uncoated pipe. Epoxycote moisture and chemical resistance virtually puts an end to pitting.

REDUCED CLEAN-UP EXPENSE: Pigging a new line to remove loose rust and millscale can cost up to 17¢ a foot, but after cleaning and lining with Epoxycote, a single plug is usually sufficient. Napko Epoxycote has maximum hardness to help prevent pigging damage.

CLEANER LINES & GAS: All rust and loose millscale can not be removed from uncoated pipe by pigging. Prior lining with Epoxycote minimizes load on scrubbers, with the cleaner gas ultimately reducing service of consumer gas appliances by the gas distributing company.

INCREASED CAPACITY: Friction losses are reduced by smoother internal surface.

PREVENTS INTERNAL CORROSION: Minute traces of moisture, oxygen, and such contaminants as hydrogen sulfide, accelerate pitting of uncoated pipe. Epoxycote Pipeliner is chemically resistant to the corrosive impurities of natural gas, insuring maximum protection of the line and the product.

NAPKO CORPORATION

INDUSTRIAL COATINGS DIVISION

P. O. BOX 14126 • HOUSTON 21, TEXAS

● **Hall Construction Co., 1105 N. Carlton, Liberal, Kansas.**

Panhandle Eastern Pipe Line Co.—a 330-mile, 4 through 12-in. gathering system in western Kansas. Supervising are Mike Bell and M. E. Banning.

● **Houston Contracting Co., 2807 Buffalo Speedway, Houston 6, Texas.**

Trancontinental Gas Pipe Line Corp.—dual 30-in. crossing of the Mississippi River near St. Francisville, Louisiana.

Trans-Southern Pipeline Corp.—dual 10-in. crossing of the Mississippi River near St. Francisville, Louisiana, where field office is located under L. F. Redfearn. Superintendent: L. A. Young.

● **Majestic Contractors Ltd., 49 Jackes Ave., Toronto 7, Ontario, Canada.**

Alberta Gas Trunk Line Co., Ltd.—113 miles of 36-in. from west of Calgary to the British Columbia border; and 63 miles of 30-in. and 38 miles of 22-in. from Lovett River to Rocky Mt. House to Cynthia, Alberta. Project office for the 36-in. line is in Blairmore, Alberta, with R. L. Leonard as superintendent. Rocky Mountain House, Alberta, is site of project office for 22 and 30-in. lines and K. B. Killingsworth is superintendent.

● **J. P. Neill and Company, Meadows Building, Dallas, Texas.**

Pacific Gas Transmission Company—468 miles of 36-in. from California-Oregon boundary to Rosalia, Washington, as joint venture with Western Pipeline, Inc., Austin, Texas.

● **Panama, Inc., 1801 Tennessee Bldg., Houston 2, Texas.**

Trunkline Gas Co.—approximately 21 miles of 30-in. from 10 miles southeast of DeRidder, Louisiana, where office is located, to 10 miles northeast, under the supervision of C. J. Hendrickson; and about 21 miles of 30-in. from Mississippi, southeast of Memphis, Tennessee, to Colliersville, Tennessee, northeast of Memphis. A. J. McIntyre will supervise the latter job, with headquarters site at Colliersville.

● **Panama-Williams Corp., 1418 Melrose Bldg., Houston, Texas.**

Trunkline Gas Co.—in Louisiana, 20 miles of 30-in. in the vicinity of Grove and 20 miles of 30-in. in the vicinity of Rayville, under the supervision of W. H. Shiflett and M. R. Sutton.

● **H. C. Price Co., Price Tower, Bartlesville, Oklahoma.**

Pacific Gas & Electric Co.—291 miles of 36-in. to the Oregon border from the San Francisco Bay area. Superintendent: R. L. Ezell. Office Manager: J. C. Eakin at Tulelake.

Pacific Gas Transmission Company—146 miles of 36-in. from Rosalia, Washington, to the Idaho-British Columbia border. Superintendent: G. A. Reutzel. Office manager: E. Dickson at Bonners Ferry, Idaho.

● **Price-Poole of Canada, Ltd., Box 969, Cranbrook, B. C., Canada.**

Alberta Natural Gas Company — 107 miles of 36-in. from Crowsnest Pass to the Idaho boundary at Kingsgate-Eastport. Joint venture of H. C. Price Company of Canada, Ltd., Calgary, and Poole Construction Company, Ltd., Edmonton. C. E. Shivel is superintendent, and L. D. Burden is office manager at Cranbrook, B. C.

● **River Construction Corp., Box 9127, Ft. Worth 7, Texas.**

Pacific Gas Transmission Co.—36-in. single-line crossings of the Kootenai and Pend Oreille rivers near Bonners Ferry and Sandpoint, Idaho, respectively, sites of headquarters. H. H. Mehail is superintendent.

● **Alex Robertson Co., Box 757, Paramount, California.**

William Lyles Co. (for U.S. Navy)—96-mile, 6-in. jet fuel line from Naval Air Station Lemoore to Estero Bay, California. Superintendent: Ken Pratt. Headquarters: Avenal, Shandon, Atascadero.

● **Sharman, Allen, Gay & Taylor, Inc., Box 13152, Houston, Texas.**

Seadrift Pipeline Co.—112 miles of 6-in. products line from Seadrift to Markham, Texas. Headquarters: Port Lavaca. Superintendent: T. L. Beard.

● **Sheehan Pipe Line Construction Co., 514 National Bank of Tulsa Bldg., Tulsa, Oklahoma.**

Transwestern Pipeline Co.—a 600-mile gathering system of 4, 6, 8, and 10 in., in Oklahoma, Texas, and New Mexico. Project personnel: J. W. Brown, H. J. Smith, Boyd Douglas, and Warren Mulkey.

● **Stanley-Bledsoe Corp., 612 Daniel Bldg., Tulsa 3, Oklahoma.**

Pacific Gas Transmission Co.—double-jointing and yard-treating 466 miles of 36-in. pipe in three schedules in Klamath, Jefferson, Umatilla, and Gilliam counties, Oregon, and Walla Walla and Whitman counties, Washington. Superintendent: W. D. Smith, Jr.

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EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

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● **Turriff-Burden, Ltd., Turriff Bldg., Great West Rd., Brentford, Middlesex, England.**

Iraq Petroleum Co. Ltd.—315 miles of 30 and 32-in. pipeline from Kirkuk to the Syrian border, connecting Rumaila and Fao. W. T. Barker manages the project office in London, England. Field construction superintendent is John H. Miller; assistant superintendent is Arnold Smith; and manager of the field office in Baiji, Iraq, is G. E. Suagee.

● **Roy Vickers Lease Service, Box 648, Robstown, Texas.**

Seadrift Pipeline Co. — 80-mile dual 6-in. LPG line as joint venture with H & K Construction Company starting at Markham and ending at Baytown, Texas.

● **Western Pipeline, Inc., 311 East 11th Street, Austin, Texas.**

Pacific Gas Transmission Company—468 miles of 36-in. from California-Oregon boundary to Rosalia, Washington, as joint venture with J. P. Neill and Company, Inc., Dallas, Texas. J. C. Oliver is project manager. Johnnie Wells is superintendent on a 150-mile segment between Malin and Bend, Oregon; and Ervin Simpson is superintendent on 150 miles between Bend and north of Ione, Oregon.

Trunkline Gas Co.—21 miles of 30-in. in Kentucky from La Center to Columbus, and 21 miles of 30-in. in Illinois from New Dennison to Vienna. Headquarters: for the former, La Center, with D. C. Arnett as office manager; for the latter, Marion, Illinois, with Harry Murphy as office manager. Superintendents: for the former, J. B. Miller; for the latter, W. E. Wells.

● **Williams Bros. Co., National Bank of Tulsa Bldg., Tulsa, Oklahoma.**

National Iranian Oil Co.—a 516 mile, 8-in. petroleum products line in Iran from Rey, near Tehran, northeast to Meshed.

Calnev Pipe Line Company—240 miles of 8-in. products line from Las Vegas, Nevada, to Colton, California. Field office at Las Vegas, M. O. Thompson, superintendent.

Bataafse Petroleum Maatschappij, N.V.—a 157-mile, 20-in. pipeline in Indonesia. Field office: Balikpapan. Superintendent: J. Childress.

Niederoesterreichische Gasvertriebs, AG (NIOGAS)—47 miles of 8 through 10-in. in Austria. Headquarters: Herzogenberg. Superintendent: W. Tierney.

Service Pipe Line Co.—a 3-line Arkansas River crossing in Pawnee and Osage counties, Oklahoma (11,000 ft of 12-in. and 5500 ft of 6-in.). Jim Martindale is superintendent, with headquarters located at Osage, Oklahoma.

● **H. B. Zachry Co., Box 10188, San Antonio 21, Texas.**

Natural Gas Pipeline Co. of America—55 miles of 20-in. between Falfurrias and Hebbronville, Texas, where field office is located.

News of PIPELINERS

John Getgood

▸ **John Getgood** has been appointed president of Pacific Petroleums, Ltd. He succeeds **George L. McMahon,** who is now vice chairman of the board. Getgood, prior to assuming the presidency of Pacific, was vice president of Phillips Petroleum International Corp.

▸ **Transcontinental Gas Pipe Line Corporation** has named **C. D. Richardson** superintendent of its newly-created Pennsylvania storage department, which will establish headquarters in Williamsport, Pennsylvania, and be staffed by **Robert M. Detamore, John S. Noel, W. L. Summers, Jr.,** and **Fred Lydic.** This new group will be responsible for operation and maintenance of Transco's facilities extending from the main line in Somerset County, New Jersey, to the natural gas storage area in western Pennsylvania and serve as field liaison with the Leidy Storage Pool.

▸ **Edwin M. Hubach** and **P. D. Campbell** have been elected vice presidents of Williams Brothers Company. Hubach, formerly in charge of the company's operations in Venezuela, will be responsible for domestic and Canadian construction operations. Campbell, who has worked on and supervised construction projects in Venezuela, Colombia, Bolivia, Chile, Canada, Indonesia, Iran, Turkey, and Austria, will be in charge of Williams Brothers operations in Europe, Africa, the Middle East, and Far East.

▸ **Howard S. McCray,** who, for the past two years, has served as assistant to the president of Texaco, Inc., has been elected president of The Texas Pipe Line Company, succeeding **John W. Emison** who will retire April 1 after 41 years of service. McCray joined Texaco in 1926 as an engineer at the company's Port Arthur, Texas, refinery. He has served as superintendent of other Texaco refineries, and as manager of the refining department's operations division and the company's purchasing department. In 1958, he was elected chairman of the board and chief executive officer of Texas-Zinc Minerals Corporation, a uranium company jointly owned by Texaco and the New Jersey Zinc Company.

▸ **Texas Gas Transmission Corporation** has appointed **Aaron H. Griffin** to manage its Louisiana division. He succeeds **William O. Davis,** who is now manager of the pipeline division at Memphis, Tennessee. New assistant manager of the Louisiana division is **L. T. Sloan. Wayne Sweet** has been named assistant superintendent of the measurement department in the company's home office at Owensboro, Kentucky.

A. H. Griffin

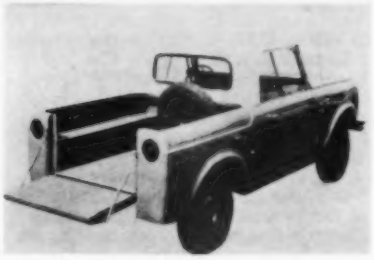
▸ **Tennessee Gas Transmission Company's** vice president, **W. D. Walser,** is general chairman of the 1961 southern conference of the Controllers Institute of America being sponsored by the institute's Houston Control March 2-4 in Houston, Texas.

▸ **George D. Eichenberger Jr.,** has been assigned as an engineer in Ohio Fuel Gas Company's engineering and planning section.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

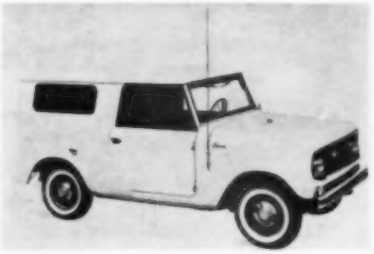
It's New | Pipeline Equipment

Pickup . . .



Open Runabout . . .

With Optional Travel-Top



The new all-purpose IH "Scout," for low cost transportation of passengers and cargo, features a 3-person cab with removable steel top and 5-ft integral pickup body. With top removed, the "Scout" becomes an open runabout. Windows and doors, as well, are removable . . . and the windshield folds down. A full-length, one-piece steel "Travel-Top" is optional. The "Scout" features 100-in. wheelbase, overall length of 12 ft, 10 in., and "Comanche" 4-cylinder engine with approximately 90 hp. Two-wheel-drive and four-wheel-drive models are offered, plus such equipment as snow plow, winch, power takeoff, and extra gas tank. *International Harvester Co.*

Circle number (81) on reply card.

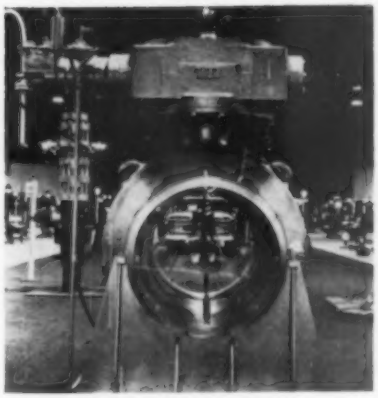
Meet Larger Payload Demand

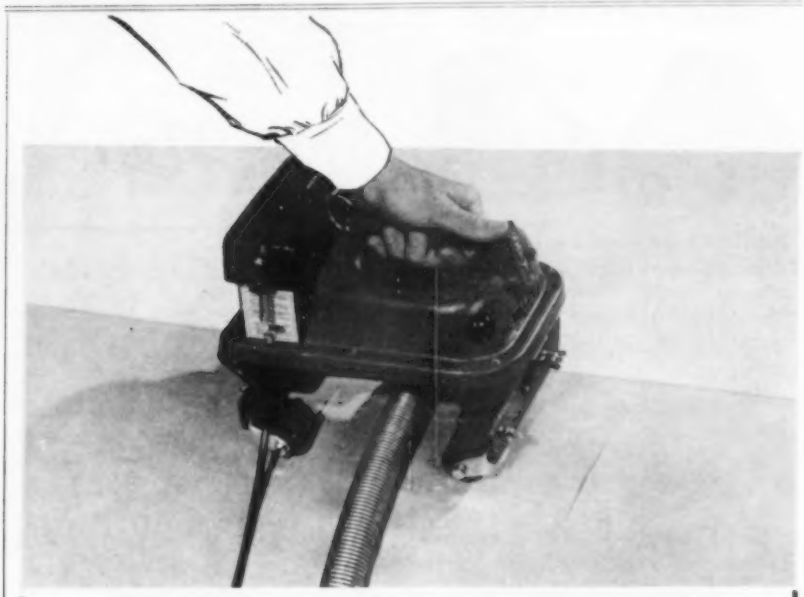
Designed for big tonnage jobs and work under large loading shovels and draglines are the two largest rear dump haulers in the Euclid line, for which rated payload capacities have been increased to 90,000 and 124,000 lb. They are models R-45 and R-62, superseding the 40 and 55 ton rear dump "Eucs." Use of high strength alloy steel for all body wearing surfaces is said to cut net weight and increase rated payload with no compromise on body strength and durability. *Euclid Div., General Motors Corp.*

Circle number (82) on reply card.

New Plug Valves Sizes

Three new sizes have been added to the "Hypresphere" lubricated plug valve line for gas, crude, and products pipeline use. Now the compact, quarter-turn, lubricated plug valve—especially designed for conditions requiring a full-opening, round bore valve—is offered in 12, 16, 20, 24, 30, 34 and 36-in. The complete line is adaptable to all types of power operation, automatic emergency shut-off, remote control. *Rockwell Manufacturing Co.* Circle number (83) on reply card.





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ELIMINATE HOLIDAYS and their consequences with accurate, reliable SPY Holiday Detectors. Compact and light in weight for one-man operation. Carrying or rolling models available. Detectors set to your job specifications:

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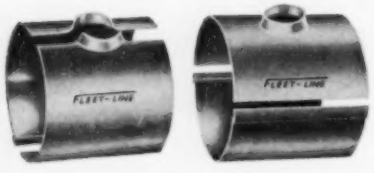
...ask for it now.

REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.

SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Full encirclement saddles.



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Dealers and Stocking Distributors throughout the United States and Canada.

All orders acknowledged by air mail or long distance telephone and filled at once.

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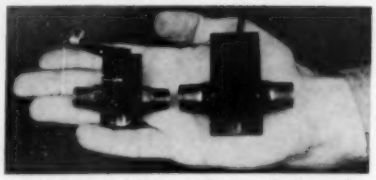
Miniature Valves



Three-way "Micro Valves," featuring male pipe connections which turn permitting installation without unions, are being offered with a variety of orifice sizes, materials, and types of operators. For operating pressures up to 100 psi, they feature fast, positive snap-action. Long life and reliability are claimed, even when handling dirty or abrasive materials. Two or more valves may easily be manifolded together for multiple operation. *Instruments, Inc.*

Circle number (84) on reply card.

Speedy Cable Layer

For laying cable precisely at specific depths in a fraction of the time formerly required and with 60 to 90 percent less cost, a new cable laying attachment is announced. The new Kelley cable layer can be attached to all Caterpillar track-type tractors equipped with Cat hydraulic control and can lay any cable or wire up to 3½-in. O.D.—at depths ranging from a 12-in. minimum with the Cat D4, to a 72-in. maximum with the Cat D9. The Kelley layer has been known to average about a mile of cable each hour. When a Kelley extra-heavy duty ripper was used in conjunction to open a path for the cable layer, production was nearly doubled. Cable laying in connection with the government's missile program is looming as a possible source of considerable work for pipeline contractors. *Kelly Products Div., Crutcher-Rolfs-Cummings, Inc.*

Circle number (85) on reply card.

It's New | Pipeline Literature

Cathodic Protection test stations, field jointers, temporary pipe plugs, plastic casing seals, pipe slings, and road crossing casing insulators are described graphically, with specifications, in a new catalog. *Greenhead, Inc.*

Circle number (86) on reply card.

Checks Coating, Finds Pipe — says new literature on the Pipetron model 506 buried holiday detector. How this multipurpose instrument operates and some of its features are the subject of the illustrated bulletin. *Pipetron Co.*

Circle number (87) on reply card.

Introducing...

the Shellfish

UNDERWATER

FERROUS METAL DETECTOR

The F. H. Maloney Company now offers an underwater ferrous metal detector: The *Shellfish*. Manufactured under license from the Shell Development Co., the detector locates pipe lines and crossings buried to depths as great as 15 feet, depending on pipe size.

The *Shellfish* saves barge, workboat-crew, and diving time, and can be handled on any boat normally used in offshore operations. It is available on day-, month-, or year-lease. For details and leasing information, please contact The F. H. Maloney Company, Houston.

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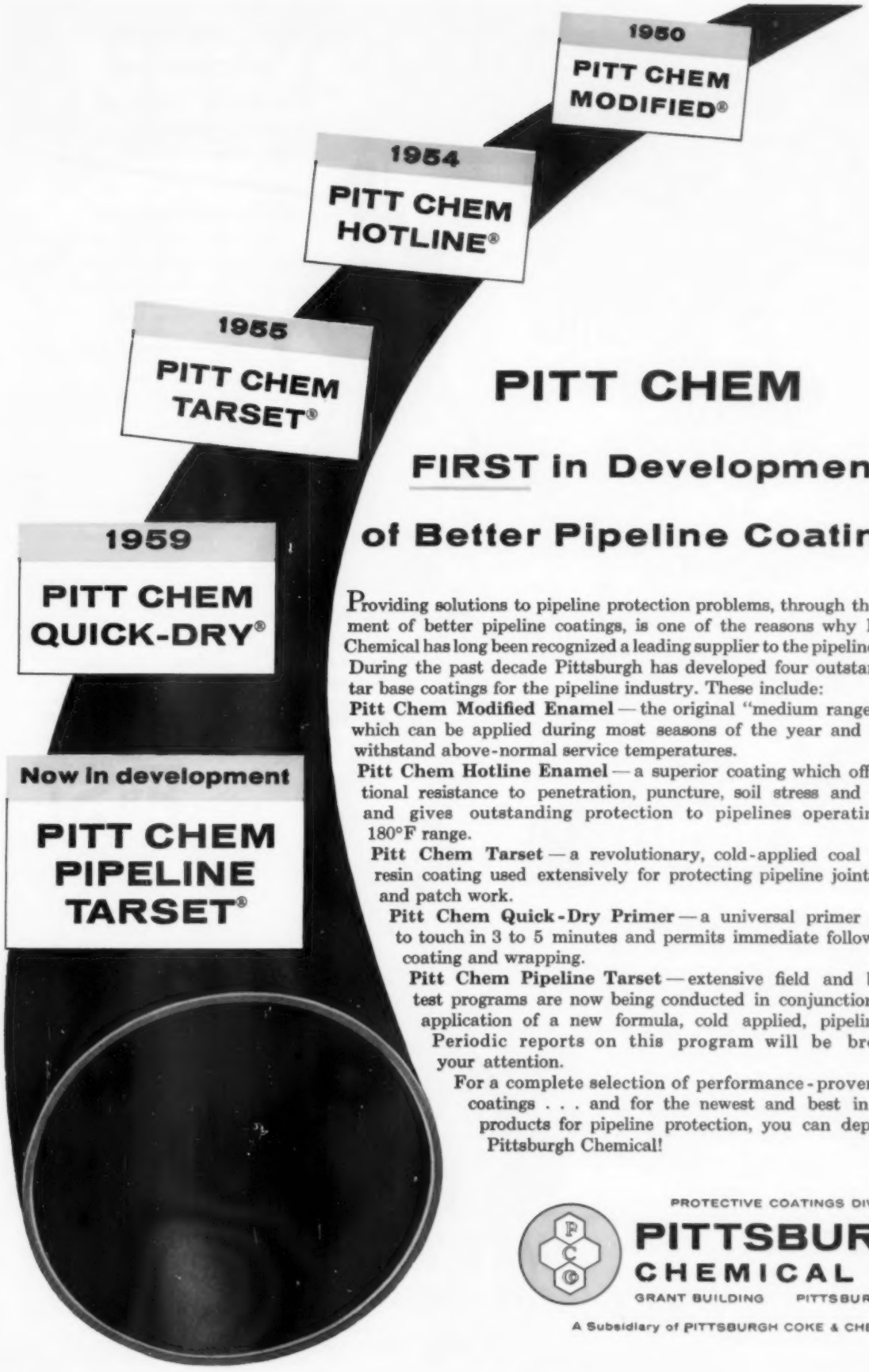

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FIRST in Development of Better Pipeline Coatings!

Providing solutions to pipeline protection problems, through the development of better pipeline coatings, is one of the reasons why Pittsburgh Chemical has long been recognized a leading supplier to the pipeline industry. During the past decade Pittsburgh has developed four outstanding coal tar base coatings for the pipeline industry. These include:

Pitt Chem Modified Enamel — the original "medium range" coating, which can be applied during most seasons of the year and is able to withstand above-normal service temperatures.

Pitt Chem Hotline Enamel — a superior coating which offers exceptional resistance to penetration, puncture, soil stress and distortion and gives outstanding protection to pipelines operating in the 180°F range.

Pitt Chem Tarset — a revolutionary, cold-applied coal tar-epoxy resin coating used extensively for protecting pipeline joints, fittings, and patch work.

Pitt Chem Quick-Dry Primer — a universal primer that drys to touch in 3 to 5 minutes and permits immediate follow-up with coating and wrapping.

Pitt Chem Pipeline Tarset — extensive field and laboratory test programs are now being conducted in conjunction with the application of a new formula, cold applied, pipeline Tarset. Periodic reports on this program will be brought to your attention.

For a complete selection of performance-proven pipeline coatings . . . and for the newest and best in *improved* products for pipeline protection, you can depend upon Pittsburgh Chemical!

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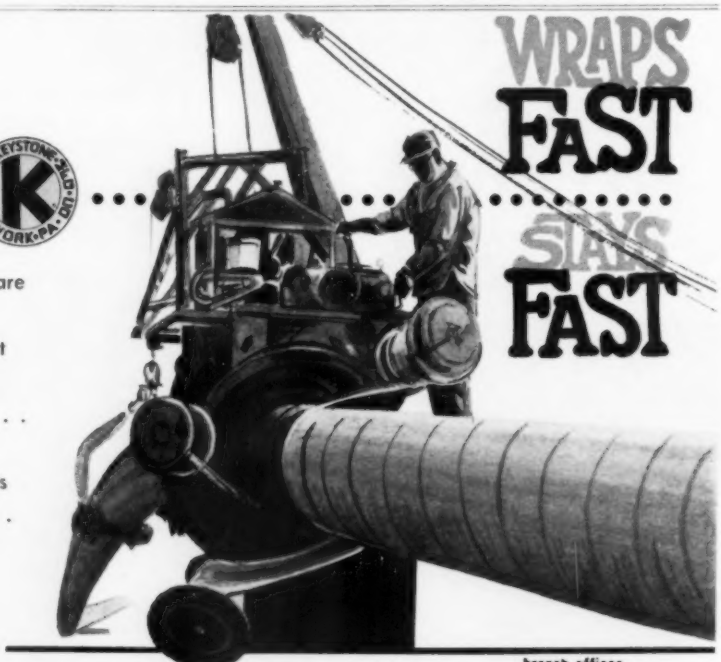
High-speed wrapping and long-time protection are among the outstanding features of Keystone Keybestos pipeline felt. A parallel reinforcement of glass yarns on ¼" centers makes Keybestos especially suitable for high speed application . . . with fewer breaks . . . fewer holidays. The tough Keystone coating resists damaging impacts during handling, lowering-in and backfilling . . . and the material is specially engineered to withstand the attacks of corrosive soil acids.

Keystone felt is available plain or perforated... tar or asphalt saturated... reinforced or non-reinforced... and in widths of 2"-36" ...lengths of 50'-2000'... and weights of 8 and 15 pounds. Contact a Midwestern Man today for complete details on the proven advantages of Keybestos Felt.



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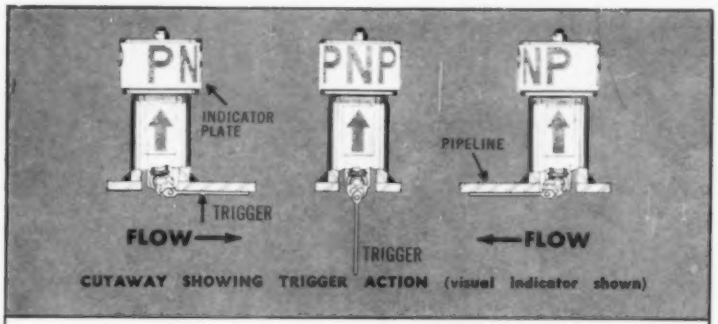
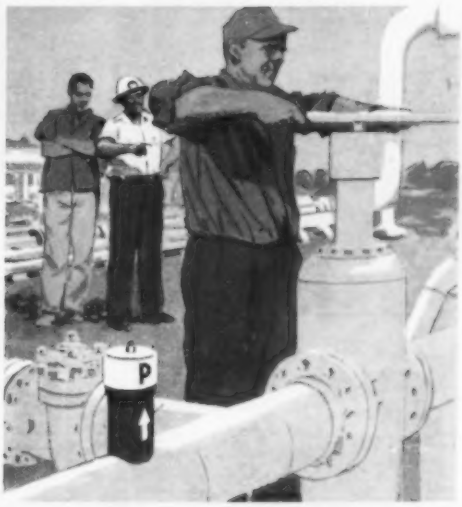
NEWS FROM DOWN THE LINE!

Successful PIG-SIG II
now has NEW BI-DIRECTIONAL TRIGGER
Plus Other Optional Features



CUTAWAY SHOWING TRIGGER ACTION (visual indicator shown)

• The WmSon PIG-SIG II Scraper Passage Indicator which has earned such wide acceptance in the pipeline industry is now available with bi-directional trigger as an optional feature. The trigger is designed for use in lines where scraper travel may be in either direction and in meter proving loops. Other optional features: pneumatic control with automatic reset and automatic counter to record scraper passage.



Long trigger action detects scrapers even in oversize pipe

PIG-SIG II PATENT PENDING

In the top example, PIG-SIG II with visual indicator shows the station operator the pig has arrived. He doesn't need to wait and listen at the scraper trap. The next example shows how PIG-SIG II with electric indicator can signal arrival of pig to pump station operator. It can start operation of automatic equipment to open and close valves. PIG-SIG II is easily installed under pressure with WmSon-Hillco Tapping Machines. It is available with visual indicator and manual reset; electrical or pneumatic signal with automatic reset; extended or regular.

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REPRESENTATIVES AROUND THE WORLD

PIG-SIG II can be used to actuate pneumatic and electric control systems. WmSon engineers may be able to offer dollar saving tips on its use in such systems. **Contact your representative or the Tulsa office.**

Engineering, Design, Consulting Services offered by a new Petrolite Corporation subsidiary, Internuclear Company, are described in two new brochures. One describes the company's role in the application of electronic computers; the other describes the company's role in the rapidly expanding nuclear energy field. *Internuclear Co.*

Circle number (88) on reply card.

Repairing Broken Castings without the use of heat is presented in a 12-page picture study. Before-and-after photographs of broken castings of which both original strength and alignment have been restored, serve to identify the broad fields in heavy industrial equipment and machinery repair this service covers. This includes cylinder heads, manifolds, engine frames, steam pressure vessels, and many others. *Reynolds-French & Co.*

Circle number (89) on reply card.

Rapid Internal Communications systems are outlined in new literature just released on USI Type 50 fully automatic machine ringing private telephone systems. Features, equipment, method of operation, and installation of the operator-less systems are covered. *United States Instrument Corp.*

Circle number (90) on reply card.

Free Test Sample of new TM&M Glass Wrap! Introduced for maximum protection of all pipelines at minimum cost, it is described in a new bulletin as having minimum 8-lb tear strength, minimum 80 lb per 6-in. width tensile strength, and thickness of 20 mils ± 2 mils. Controlled placement of individual continuously drawn glass fibers is said to eliminate wrapping breaks, moisture wicking, and "jeeping". *Texas Metals & Minerals Corp.*

Circle number (91) on reply card.

NEW
Arno
PIPE-WRAP TAPE
Positive Protection for Buried Pipe
Here's pipe protection by the roll. Pipe-Wrap is made of stretchy, inert polyethylene with a pressure-sensitive adhesive to provide a tough, continuous barrier against rust, acids, alkalis and electrolytic currents. Saves time and money.

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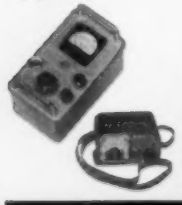

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This radically new, super-powered, transistorized instrument weighs only four pounds and is one-fourth the size of conventional pipe locators.

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An exclusive summary of contract rigs . . . world-wide . . . available for work; including rig location, type, specifications, contractor's name and address. Major divisions: rotary, cable tools, well servicing, off-shore . . . and new expanded international section.
SPRING 1961
RIG LOCATOR
A SUPPLEMENT TO
THE PETROLEUM Engineer
DALLAS 21, TEXAS

BIG FOOTAGE IN ALL FORMATIONS

TYPE ES—salt, red beds, gypsum, anhydrite, unconsolidated shales, medium-hard limestones.

TYPE EM—hard shales, sandy shales, hard limestones, anhydrite.

TYPE EH—chert, quartzite, granite, flint, novaculite, pyrite bearing quartzite, basalt.

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BIG FOOTAGE IN ALL FORMATIONS

The only true measure of a Rock Bit is its ability to make hole! . . . These factors are *musts* for high penetration performance:

OUTSTANDING METALLURGY that insures long wear of cones and journals . . . maximum resistance to chipping and breakage of bearings under shock loads.

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REAMERS • TOOL JOINTS

17th EDITION SPRING 1961

WORLD-WIDE

RIG LOCATOR

Including U. S. and Canadian Well Servicing Units
Plus Enlarged International Section

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RIG LOCATOR

THE LARGEST NUMBER of contract drilling and well servicing units ever listed in any industry publication are contained in this ... the 17th edition of The Petroleum Engineer's exclusive World-Wide RIG LOCATOR ... now entering its sixth year of service to the contractor and producer. From its inception in the fall of 1955, only contract equipment was listed ... in keeping with its aims and purpose: to serve the contractor by briefly describing his rigs with pertinent specifications and indicating their current location; and to serve the producer by providing him with a complete listing of rigs to meet his requirements in almost every area where wells are drilled. "Captive" or producer-owned rigs not available for contract work are NOT included in this directory ... nor ever have been included.

Over 3000 Rigs Listed

For the first time since the hey-days of 1956 has the number of rigs listed gone over the 3000-mark. Some 780 contractors sent in rig data ... a most encouraging response! Of this number, almost 2200 are U.S. rotary rigs ... about 400 more than were shown active by the Hughes Tool Company rig report to the American Association of Oilwell Drilling Contractors when this list went to press. In Canada, there are over 235 rotary rigs available for contract work at a time when about 180 were making hole. The number of well servicing rigs listed hit an all-time high of over 750 for the U.S. alone, representing 167 contractors. The U.S. offshore rig list climbed to 68 ... a significant gain, especially when it is realized that many offshore (Louisiana) rigs are producer-owned and operated.

International Section Expanded

By popular demand... and, in keeping with our continuing efforts to improve the RIG LOCATOR ... we have expanded the International Section which lists almost 200 contract rotary rigs. This is far from complete we realize ... but a good start in our effort to encompass the globe in this unique and unparalleled rig directory. You can expect the next edition to be bigger and better. We thank those international contractors who sent us their rig data before this edition went to press. Overseas correspondence takes time and some rig data were received after this edition was printed. May we urge all contractors to send in their rig data on time. We want to include every rig possible, but must meet a printing deadline.

Our thanks to all the contractors making this directory possible.

And of the Future

While the drilling picture outside the U.S. and Canada continues its gentle upwards climb, activity in North America appears to be increasing from its February 1961 low. Slowly but surely, more and more rigs are called back to work as exploration and development drilling starts its come-back. The aggressive and progressive contractor will get his share of the available work. But he'll have to work harder for it. It is through the pages of your RIG LOCATOR that we sincerely hope the job will be made a little easier and more productive.

Use of Abbreviations

In a directory of this type where certain specifications are included, it was necessary in the conservation of space to make some abbreviations. The asterisk (*) before the "rig number" indicates the rig is also available for workover. Under the column of "type power," the following abbreviations apply: Dsl for diesel; gaso for gasoline, stm for steam; btne for butane; and dsl elec for diesel electric. In listing drawworks make and model number, it was necessary to abbreviate the manufacturer's name. Some of these abbreviations are well-known; others had to be made to fit the available space. Here's the code we used:

Manufacturer's Company Name	Abbreviation
ALCO Products, Inc. (formerly Beaumont Iron Works Div. of American Locomotive Co.)	ALCO-BIW
Allis-Chalmers Manufacturing Co.	Allis Chmrs
American Iron & Machine Works	Amer
Ansaldo	Ansaldo
Bethlehem Supply Co.	Beth
Big Four Machine & Supply Co.	Big Four
Border Foundry & Machine	Border
The Brewster Co., Inc.	Brwstr
Bucyrus-Erie Co.	B. Erie
Cardwell Manufacturing Co., Inc.	Crdwll
Clark Bros. Co., Inc.	Clark
Continental-Emsco Co.	Emsco
Fred E. Cooper, Inc.	Cooper
Cummins Engine Co., Inc.	Cummins
George E. Failing Co.	Failing
Franks Division of Cabot Shops, Inc.	Frnks
General Machine Co.	Gen Mach
Hacker Machine & Supply Co.	Hacker
Hopper Machine Works, Inc.	Hopper
Houston Tool Co.	Hou
Howard-Turner Machine Works	Howard-Turner
Ideco, Inc.	Ideco
Ingersoll-Rand Co.	Ingersoll
Jones, Shelburne & Guffey Co.	JS&G
Joy Manufacturing Co.	Joy
Lucey Export Corp.	Lucey
Mayhew Supply Co., Inc.	Mayhew
Mid-Continent Supply Co.	M-CSCO
Lee C. Moore Corp.	L. C. Moore
Muskogee Iron Works	MIW
The National Supply Co.	Natl
Oil Well Supply Division (U. S. Steel Corp.)	"Oilwell"
Reich Bros.	Reich
Spencer-Harris Machine & Tool Co.	Spencer
Stardrill-Keystone Co.	Star
Texas Iron Works, Inc.	TIW
Vickers, Inc.	Vickers
Victoria Machine Works	Vic
Wagner-Morehouse, Inc.	Wgnr-Mrhse
Waldrip Engineering Co.	Wldrp
Walker-Neer Manufacturing Co., Inc.	Wlkr-Nr
Well Machinery & Supply Co., Inc.	Ft Wrth
Wheeling Machine Products Co.	Wheeling
The Wheland Co.	Whlnd
Wichita Tool Supply Co.	Wich
Wichtex Machinery Co., Inc.	Wichtex
Wilson Manufacturing Co., Inc.	Wlsn

U. S. Rotary Drilling Contractors

A

Ace Drlg Co 1313 Republic Natl Bk Bldg Dallas Tex
Akin & Dimock 714 Holliday St Wichita Falls Tex
Alan Drlg Co 807 Oil & Gas Bldg Wichita Falls Tex
Allen & Morris Drlg Co 820 Alamo Natl Bldg San Antonio 5 Tex
Allen & Shumate Inc P O Box 98 Alice Tex
Allison Drlg Co 626 Patterson Bldg Denver Colo
Appell Petroleum Corp Drawer 330 Alice Tex
Arapahoe Drlg Co 1020 Petroleum Club Bldg Denver Colo
Arrow Drlg Co 407 Philtower Bldg Tulsa 3 Okla

B

B B M Drlg Co 673 San Jacinto Bldg Houston 2 Tex
B-M Drlg Co Inc Box 5218 Bossier City La
Bailey Pernie 2309 Sage Rd Houston 19 Tex
Ballew Dorris Inc Box 561 Natchez Miss
Barnes Core Drlg Co 1350 Roberts Ln Bakersfield Calif
Barnett Drlg Inc 409 First Natl Bk Bldg Wichita Kans
Barnwell Drlg Co Inc Box 1748 Shreveport La
Barrett Petroleum Co 423 Masonic Bldg Shawnee Okla
Barry Well Drlg Co West Star Rt Fallon Nev
Bass Drlg Co 905 San Jacinto Bldg Houston 2 Tex
Bass Robert M Drlg Contr Box 471 Kilgore Tex
Bayer-Hunefelt Drlg Co 119 Petroleum Life Bldg Midland Tex
Bennett & Roberts Drlg Inc Drawer 633 Russell Kans
Bernhardt Drlg Co 2469 Grand River Detroit 1 Mich
Berry Drlg Co Box 67 Saint Jo Tex
Bickerstaff and Tibbets Drlg Co 406 N Marienfeld Midland Tex
Big Chief Drlg Co Box 8837 Oklahoma City 14 Okla
Big Horn Drlg Co Inc Box 2068 Casper Wyo
Big Seven Drlg Co 311 Wright Bldg Evansville Ind
Big "6" Drlg Co 225 Oil & Gas Bldg Houston 2 Tex
Big X Drlg Co Inc 2905 First Natl Bldg Oklahoma City Okla
Black Drlg Co 525 Petroleum Bldg Abilene Tex
Henry Black Drlg Co Inc Box 174 Midland Tex
Blackstock Forest Inc V & J Tower Bldg Midland Tex
Bodard Drlg Co 313 Masonic Bldg Shawnee Okla
Bolin Oil Co & D H Bolin 1120 Oil & Gas Bldg Wichita Falls Tex
Boyd & Durst Drlg Contr Box 329 Alice Tex
Brannon & Murray Drlg Co Box 672 Coleman Tex
Brantly Drlg Co Inc Box 4935 Midland Tex
Brehn C E Drawer 618 Mt Vernon Ill
Brewster-Bartle Drlg Co Inc 1919 Bk of Southwest Bldg Houston 2 Tex
Brooks Zach Drlg Co Box 31 El Dorado Ark
Brown Drlg Co Box 197 Long Beach Calif
Brown Layton Drlg Co Box 185 Woodsboro Tex
Bryant Harry T Co Ltd Box 13364 Houston 19 Tex
Bryant-Hayward Drlg Co Box 4627 Oklahoma City Okla
Bueno Drlg Co 207 Continental Oil Bldg Denver 2 Colo
Buick Drlg Inc 409 Wolcotte Bldg Hutchinson Kans
Burger Drlg Co Box 327 Coleman Tex
Butler-Johnson Inc Box 306 Shreveport La
Buzzini Drlg Co Petroleum Center San Antonio 9 Tex
Byars B G Power Drlg Co 624 Citizens Bk Bldg Tyler Tex

C

Cactus Drlg Corp of Tex Box 348 San Angelo Tex
Caldrill Inc 3400 Loma Vista Rd Ventura California
Calvert Drlg Inc 918 Natl Bk of Tulsa Bldg Tulsa Okla
Camay Drlg Co 4250 Wilshire Blvd Los Angeles 5 Calif
Camay Drlg Co Rocky Mt Div 1535 Denver Club Bldg Denver 2 Colo
Camden Drlg Co Box 1418 Corpus Christi Tex
Canadian River Drlg Co 424 Petroleum Bldg Amarillo Tex
Caraway Frank Drlg Co Box 982 San Angelo Tex
Carper Drlg Co Inc Box 905 Hobbs N M
Catline Dodson Co Inc Box 8503 Oklahoma City Okla
Central Drlg Co 704 10th St Lawrenceville Ill
Chief Drlg Co Inc 4600 10th St Pl Great Bend Kans
Chiles Drlg Co Box 949 Alice Tex
Circle Drlg Co Inc 620 Pioneer Bldg Lake Charles La
Clark Dan L Drlg Co 819 Wilson Tower Corpus Christi Tex
E B Clark Drlg Co 612 City Natl Bk Bldg Wichita Falls Tex
Clawson Don Townsend Bldg Ada Okla
Claypool Drlg Co Box 98 St Elmo Ill
Clegg & Hunt 715 Houston Club Bldg Houston Tex
Coastal Drlg Co 7300 Downing Ave Bakersfield Calif
Colorado & Western Drlg Co 1119 Mile High Center Denver 2 Colo
Columbia Drlg Co 1207 C & I Life Bldg Houston 2 Tex
Comet Drlg Co Box 1143 OCS Lafayette La
Conrey Drlg Co 328 E Broadway Centralia Ill
Continental Drlg Co 1010 Commerce Bldg New Orleans La
Cook Drlg Co 2305 Continental Life Bldg Ft Worth Tex
Cooper Drlg Co 902 Staley Bldg Wichita Falls Tex
Coroco Drlg Co 2000 Mercantile Bk Bldg Dallas 1 Tex
Crawford Drlg Co Box 622 Shreveport La
Cross Jess P Drlg Contr 1216 Texas St Graham Tex
Crow Milton Inc 420 Commercial Natl Bk Bldg Shreveport La
Crown Drilling Company 612 First Natl Bldg Oklahoma City, Okla

D

D-K Drlg Co Box 866 Cortez Colo
D & M Drlg Co Inc 809 Union Center Wichita 2 Kans
Darden R W Drlg Co Box 576 Olney Tex
Davidson Drlg Co Inc 1004 Continental Life Bldg Ft Worth Tex
Davis & Bates Inc 1724 Milam Bldg San Antonio 5 Tex
H Davis & R H Thompson Co Calif
Davon Drlg Co Box 1586 Oklahoma City 9 Okla
Delaney M J Co 910 Dallas Fed Savings Bldg Dallas 1 Tex
Delta Drlg Co Box 2012 Tyler Tex
Dillard-Waltermire Inc 109 Oil & Gas Bldg Houston 2 Tex
Dillier W L Box 205 Casey Ill
Dixie Drlg Co Inc 2715 Mercantile Bank Bldg Dallas Tex
Dixilyn Drlg Corp Box 3427 Odessa Tex
Dixon Drlg Co Box 2320-340 Pet Bldg Abilene Tex
Drillers Inc 2005 Adolphus Tower Dallas Tex
Drlg & Expl Co of Del Inc Box 35366 Dallas 35 Tex
Drlg & Prod Co 2907 L St Bakersfield Calif
Dual Drlg Co 606 City Natl Bk Bldg Wichita Falls Tex
Dudley & Heath Drlg Co Box 428 Stillwater Okla
Dugger & Herring Drlg Co 203 Crescendo Bldg Abilene Tex
N V Duncan Drlg Co 306 Local Federal Bldg Oklahoma City Okla
Durham Drlg Co Inc Box 204 Midland Tex

E

Eakle & Holder Drlg Co 116 Mulberry St Evansville Ind
Eason T T Co Div of Eason Oil Co Box 9755 Okla City 18 Okla
Edman Drlg Co San Jacinto Bldg Houston Tex
Edwards Harry L Drlg Co Box 35066 Houston 35 Tex
Eggleston A W Inc Box 425 Crowley La
Eilers Drlg Co Box 169 New Iberia La
Empire Drlg Co 650 Fourth Natl Bk Bldg Wichita 2 Kans
Empire Drlg Co 1403 Texaco Bldg Dallas 1 Tex
Exeter Drlg Co 919 Midland Svgs Bldg Denver Colo
Ewing Drlg Co Box 807 Breckenridge Tex

F

Fairman Drlg Co Hammersley Fork Pa
Falco Drlg Co Inc Box 1255 Alice Tex
John O Farmer Inc Russell Kans
Felderhoff Bros Drlg Co Box 87 Muenster Tex
Fitzpatrick Drlg Co 803 Wilson Tower Corpus Christi Tex
Fitzpatrick Drlg Co Inc Box 639 Casper Wyo
Fleeger Drlg Inc 271 Meadows Bldg Dallas 6 Tex
Fletcher J B Drlg Co 1100 Petroleum Tower Shreveport La
Flournoy-Haston Drlg Co Inc Dowling Bldg Ardmore Okla
Foree Drlg Co 607 First Natl Bk Bldg Dallas 2 Tex
Fortune Drlg Corp Petroleum Bldg San Angelo Tex
Foster C J Drlg Co Inc Box 657 Richmond Tex
Armstrong Fowler Inc 929 Oleander Bakersfield Calif
Frawley Frank Drlg Co 823 S Detroit Tulsa 3 Okla
French Lloyd R 506 V & J Tower Midland Tex
Frontier Drlg & Prod Co 216 Petroleum Life Bldg Midland Tex
Fryer & Hanson Drlg Co 2520 Republic Bk Bldg Dallas Tex
FWA Drlg Co Inc 300 1st Natl Bank Bldg Wichita Falls Tex

G

Gardner Bros Drlg Co Inc 1718 Davis Bldg Dallas Tex
Garr-Woolley Oil Co 901 Cravens Bldg Oklahoma City Okla
Garvey Drlg Co Route 2 Great Bend Kans
Gary Drlg Co Box 58 Oil City La
Gateway Petroleum Co Inc 723 Southland Center Dallas Tex
General Well Drlg Box 1315 Alice Tex

Gilmour Drlg Co Box 1082 Alice Tex
Gibson Drlg Co 712 City Natl Bk Bldg Wichita Falls Tex
Gist Expl Co Box 1731 Casper Wyo
Willard Gladson & Odstrcil Bros Drlg Co 2705 W 35th St Snyder Tex
Goff-Leeper Drlg Co Box 1749 Ardmore Okla
Gore Drlg Co Box 515 Albany Tex
Gorman T V Drlg Contr 621 Staley Bldg Wichita Falls Tex
Grace H O Drlg Co 632 Wichita Natl Bldg Wichita Falls Tex
Jack Grace Drlg Co 1009 City Natl Bldg Wichita Falls Tex
Luke Grace Drlg Co 1020 Oil & Gas Bldg Wichita Falls Tex
Gracey-Hellums Corp 410 S Coast Bldg Houston 2 Tex
Graham Drlg Co 2nd Floor First St Bk Bldg Temple Okla
Graham & Klassen Drlg Co Inc 4715 Crenshaw Blvd Los Angeles 43 Calif
Graham-Michaelis Drlg Co 211 N Broadway Wichita 2 Kans
Grande Corp The 1000 Mercantile Continental Bldg Dallas Tex
Grannell Drlg Co Box 583 Casper Wyo
Grappe John Drlg Co Box 1186 Levelland Tex
Goll Graves & Mechling Inc 205 Bearinger Bldg Saginaw Mich
Graytex Drlg Co 406 Robertson Bldg Wichita Falls Tex
Great Northern Drlg Co Inc 3021 Sixth Ave N Billings Mont
Great Western Drlg Co Box 1659 Midland Tex
Green & Drewblow Drlg Co Box 1057 Bakersfield Calif
Grey-Wolf Drlg Co 1506 Bk of the Southwest Houston 2 Tex
Gross Drlg Co 1124 Douglas Rd Eldorado Kans
Guadalupe Drlg Co 2505 Princeton Ave Midland Tex
Guffey Roy Drlg Co 5543 Yale Blvd Dallas 6 Tex
Gulley, Long & Hedge Drlg Co Inc Box 567 Laird Hill Rd Kilgore Tex

H

H & S Drlg Co 407 Tri State Ins Bldg Tulsa Okla
Hack Drlg Co Box 5108 Abilene Tex
Hagestad John S Drlg Co 3224 Gulf St Bakersfield Calif
Hall Clyde Drlg Co Inc Box 4068 Bakersfield Calif
Hall O E Drlg Co 2008 Continental Natl Bk Bldg Ft Worth 2 Tex
Hamman Oil & Ref Co Box 13028 Houston 19 Tex
Haney & Williams Drlg Co 3500 Cherry Ave Long Beach 7 Calif
Hap Drlg Co 2510 First Natl Bldg Oklahoma City Okla
Harkins & Co Box 1490 Alice Tex
Harper-Turner Drlg Co 904 Hightower Bldg Oklahoma City Okla
Harris Drlg Co Box 699 Grayville Ill
Harris Drlg Co Inc P O Box 868 Eunice La
Harris John W Drlg Co 525 Wichita Natl Bk Bldg Wichita Falls Tex
Hastings J W Drlg Co 722 Wichita Natl Bk Bldg Wichita Falls Tex
Hatcher H F & Son Drlg Co Box 447 Smackover Ark
Hayward Drlg Co Box 295 Enid Okla
Helmerich & Payne Inc First Natl Bldg Tulsa Okla
The Herb Expl Co 342 Lexington Ave Abilene Tex
Herley Supply Co Inc 3040 Cherry Ave Long Beach 7 Calif
Herring 607 Kennedy Bldg Tulsa Okla
Herring Maxwell Drlg Corp 619 Citizens Bk Bldg Tyler Tex
Hewgley Drlg Co 704 Wilco Bldg Midland Tex
Hewit-Gulick Drlg Co 2555 1st Natl Bk Bldg Denver 2 Colo
Highland Oil Box 263 Jasper Ind
Hilburn Industries Inc Box 1723 Ricou-Brewster Bldg Shreveport La
Hinton W B 2900 Mercantile Bk Bldg Dallas 1 Tex
Hissom Drlg Co 1327 Wilco Bldg Midland Tex
Holliman Drlg Co 712 Fidelity Union Life Bldg Dallas Tex
Holm Drlg Co Box 7246 Tulsa 18 Okla
Holmes Drlg Co 1045 San Jacinto Bldg Houston Tex
Holt Brothers Drlg Co Box 236 Pampa Tex
Hondo Drlg Co Box 116 Midland Tex
Horizon Oil Inc 621 Staley Bldg Wichita Falls Tex
Horn Drlg Co 640 Milam Bldg San Antonio 5 Tex
Hose-Austin Drlg Corp Box 1067 Casper Wyo
Houchins Drlg Co Box 388 Mt Carmel Ill
M L Houston Drlg Co 616-4 1st Wichita Natl Bank Bldg Wichita Falls Tex
H H Howell 604 Milam Bldg San Antonio Tex
Hull Oil Co 203 Panhandle Bldg Wichita Falls Tex
Hunt Drlg Co Inc 633 Wilson Bldg Corpus Christi Tex
Hydro Drlg Co Inc 788 Petroleum Bldg Tyler Tex

I

Indian Drlg Co Box 42 Tulsa Okla
Inland Drlg Co 317 C A Johnson Bldg Denver Colo

J

J & C Drlg Co 311 Citizens Standard Bldg Corpus Christi Tex
J & C Drlg Co Box 216 Refugio Tex
Jack S W Drlg Co Allegheny Ave Avonmore Pa
Jackson A L Drlg Co Box 194 Great Bend Kans
Jett Drlg Co Inc Box 1832 Shreveport La
Johnn Drlg Co 711 Fair Bldg Ft Worth 2 Tex
Fred Johnson Drlg Co 2790 Cherry Ave Long Beach 6 Calif
Johnson-Bates Drlg Co Box 425 Konawa Okla
Jonco Drlg Co Box 1214 Seminole Okla
Jones Woody Drlg Co 408 E Main St Olney Ill

K

K & E Drlg Inc 719 Union Center Bldg Wichita 2 Kans
Kellogg K L & Sons 3777 Long Beach Blvd Long Beach 7 Calif
Kelly Drlg Co Inc Box 1126 Houma La
Kendall-Davis Drlg Co Inc 201 S E 1st St Evansville Ind
Kent Drlg Co Box 2555 Salt Lake City 10 Utah
Keoughan Drlg Co Inc Box 12246 Ft Worth Tex
Kerr-McGee Oil Industries Inc Kerr-McGee Bldg Oklahoma City Okla
Kilroy Drlg Co 2306 Bk of Southwest Bldg Houston 2 Tex
Kimbark Expl Co Box 1557 Denver Colo
King-Phillips Inc 1108 Continental Natl Bk Bldg Ft Worth Tex
Kingery Drlg Co Inc Box 97 Saint Jo Tex
Kirby Oil Ind Inc 5107 Center St Omaha 6 Neb
Kirk Drlg Co 715 First Perry Okla
Kirkpatrick Oil Co 1300 N Broadway Okla City Okla
Knight Drlg Co Box 1332 Bakersfield Calif
Kullberg & Otthouse Inc Box 967 Cut Bank Mont

L

L & F Drlg Co Box 1468 Bakersfield Calif
L & J Drlg Ltd 320 Indiana Bk Bldg Evansville Ind
L & N Drlg Co Box 8057 6709 Canal Blvd Shreveport La
Larco Drlg Co Box 3499 Jackson Miss
Laughlin-Porter Drlg Co Inc 9 Petroleum Life Bldg Midland Tex
Leatherwood Drlg Co Box 925 Jacksboro Tex
Lee Drlg Co 1007 Philtower Bldg Tulsa Okla
Lewis Will I Drlg Co 207 Continental Oil Bldg Denver Colo
Lewis Bros Inc 310 U S Natl Center Bldg Denver 2 Colo
Lindsay Ted Box 190 Mt Vernon Ill
Lin-Mour Drlg Co 1112 Oil & Gas Bldg Wichita Falls Tex
Llano Drlg Co 301 V & J Tower Bldg Midland Tex
Lloyd Drlg Co Box 355 Taft Calif
Logan Art Drlg Co Box 923 Wewoka Okla
Lohmann-Johnson Oil Co Inc 320 Indiana Bk Bldg Evansville Ind
Longhorn Drlg Corp Box 546 Three Rivers Tex
Love-Miller Drlg Co Inc 712 Patterson Bldg Denver 2 Colo
Low Drlg Co Box 1112 Cisco Tex
Lowe Drlg Co Box 832 Midland Tex
Lunsford Drlg Co 505 Louisiana Bk Bldg Shreveport La
Lynn Drlg Co 1403 Natl Bk of Tulsa Bldg Tulsa Okla

Mc

McCall Gabe Drlg Co Box 2068 Casper Wyo
McCutchin Gene Drlg Co Box 1585 Dallas 21 Tex
McCutchen & Graham 409 Oil & Gas Bldg Wichita Falls Tex
McDaniel & Beecherl Drlg Co 908 Dallas Fed Savings Bldg Dallas 1 Texas
McDonald Drlg Co 1409 Garden City Hwy Midland Tex
A D McDuffie Box 807 Wichita Falls Tex
B L McFarland Drlg Corp 3612 W Wall Midland Tex
B L McFarland Inc 3612 W Wall Midland Tex
McGoldrick & Watson Drlg Co 405 Beck Bldg Shreveport La

M

Mac Drlg Co Box 2972 Houston 1 Tex
Mallard Drlg Co 1016 Union Natl Bk Bldg Wichita Kans
Man Drilling Co 200 City National Bank Bldg Wichita Falls Tex
Mangum Drlg Co 834 Esperson Bldg Houston 2 Tex
Manning R L Co 318 Continental Oil Bldg Denver Colo
Marhill Oil & Gas Co Inc 523 Frederica St Owensboro Ky
Maritzky & Bibby Box 509 Homer La
Marlin Exploration Inc 836 Olive Shreveport La
M L (Mike) Marrs Drlg Co Box 985 Drumright Okla
Mast Drlg Inc Box 33 Russell Kans
Medford Drlg Co 500 Wichita Natl Bank Bldg Wichita Falls Tex
Melco Drlg Co Box 1360 Seminole Okla
Meredith Drlg Co 419-420 City Natl Bldg Wichita Falls Tex

Meredith & Co 1418 Bk of the Southwest Bldg Houston 2 Tex
Mesker Drlg Co Box 3655 Tulsa Okla
Midland Expl Co 222 Hughes Bldg Cushing Okla
Midwestern Drillers Inc 1206 Mid-Continent Bldg Tulsa 3 Okla
Milam Drlg Co 1814 Alamo Natl Bldg San Antonio Tex
Milhoan Drlg Co Box 948 Tulsa Okla
Gene Miller Inc Box 238 Lawrenceville Ill
Miller Bros & Bowling Box 611 Alice Tex
Miller & York Box 1664 Bakersfield Calif
Monte Christo Drlg Corp Box 1780 McAllen Tex
R B Montgomery Drlg Inc P O Box 1102 Bakersfield Calif
Montgomery Drlg Co Box 747 El Dorado Ark
Moran E W Drlg Co 500 First Natl Bk Bldg Wichita Falls Tex
Moran Bros Inc 1200 Oil & Gas Bldg Wichita Falls Tex
Moran Oil Prod & Drlg Corp Box 1718 Hobbs N Mex
Mountain States Drlg Co Inc 622 Patterson Bldg Denver 2 Colo
Mount Dale Drlg Inc 1155 Mercantile Dallas Bldg Dallas 1 Tex
R V Muckelroy & Son Adams Bldg Lockhart Tex
Murfin Drlg Co 617 Union Center Wichita 2 Kans
Murphy & McKernan Box 169 Pampa Tex

N

Neal Drlg Co 1507 Esperson Bldg Houston 2 Tex
Nemaha Oil Co 2206 Mercantile Bk Bldg Dallas Tex
Newton Drlg Co Box 1104 Coalinga Calif
Nichols Drlg Co Box 1032 Duncan Okla
The Noah Petroleum Co 23 Main St Evansville 8 Ind
Norman Drlg Corp 1141 Butternut St Abilene Tex
Norton Drlg Co 542 Nat Bk of Commerce New Orleans 12 La
Norwood Drlg Co 700 Wichita Natl Bk Bldg Wichita Falls Tex
Nowery Drlg Co Inc 5904 Fairfield Shreveport La
Nuckolls-Bell Drlg Co 1255 First Natl Bldg Oklahoma City 2 Okla
Nye & Snell Drlg Co 208 Patterson Bldg Denver Colo

O

O'Brien Davey Drlg Co Inc 615 Ft Worth Club Bldg Ft Worth Tex
Ocean Drlg & Expl Co 2475 Canal St Caribe Bldg New Orleans 12 La
Offshore Co Box 1268 Baton Rouge La
Oien Oil Corp Box 2235 Cut Bank Mont
Olds & Wrather Drlg Co Box 113 Casper Wyo
Oliver E L Drlg Co Box 103 Oklahoma City Okla
Omohundro W B Box 774 Wichita Falls Tex
O'Neal-Garvin Drlg Co Box 1289 Duncan Okla
Oney Drlg Co Box 425 Graham Tex
Orm Drlg Co 421 M & P Bk Bldg Sherman Tex
Owen Drlg Co Box 1423 OCS Lafayette La

P

Parker Drlg Co 418 Natl Bk of Tulsa Bldg Tulsa 3 Okla
Patco Drlg Contr Box 322 Stillwater Okla
Pease Willard Drlg Co Box 1532 Grand Junction Colo
Penrod Drlg Co 1320 Mercantile Securities Bldg Dallas 1 Tex
Pep Drlg Co 1002 Main St Mt Vernon Ill
Perkins Drlg Co Box 1232 Duncan Okla
Petro Drlg Co Inc Box 339 Mt Vernon Ill
Pickrell Drlg Co 705 Fourth Natl Bk Bldg Wichita 2 Kan
Pierce Drlg Co 605 Oil & Gas Bldg Wichita Falls Tex
Pioneer Drlg Co Inc Box 2211 Casper Wyo
Pool Fred Drlg Co 908 Petr Life Bldg Midland Tex
Pool & Gerlich Drlg Co Box 1940 San Angelo Tex
The Power Rig Drlg Co Inc Box 1436 OCS Lafayette La
Prairie Drlg Co Inc Box 2068 Casper Wyo
Prince Marine Drlg & Expl Co 1069 San Jacinto Bldg Houston 2 Tex
Producers Drlg Co Inc 927 Natl Bk of Commerce Bldg New Orleans La
Pyburn Drlg Co Box 4276 Shreveport La

Q

Quaker Drlg Co Inc 800 Bitting Bldg Wichita Kans

R

R-G Drlg Co 403 City Natl Bk Bldg Wichita Falls Tex
R W I T Drlg Co Box 551 Holdenville Okla
Raiborn Drlg Co 35 Garden Rd San Angelo Tex
Raymond Drlg Co 410 4th Natl Bank Bldg Wichita 2 Kan
Rebstock & Reeves Drlg Co 450 Saratoga Bldg New Orleans 12 La
Red River Drlg & Prod Co Box 169 Breckenridge Tex
Reed Drlg Co Inc 1209 Atlas Bldg Tulsa Okla
Rex & Morris Drlg Co Box 334 Eldorado Kan
Rheay & Reynolds Drlg Co 404 Petroleum Bldg Abilene Tex
Rhodes Drlg Co Box 239 Abilene Tex
Rhodes & Hicks Drlg Corp Box 1395 Alice Tex
Rimrock Tidelands Inc Box 896 New Orleans La
Rine R W Drlg Co 420 Union Center Bldg Wichita Kans
Robinson Drlg Co Box 970 Colorado City Tex
Rocket Drlg Co Inc 352 N Broadway Wichita Kans
Rocky Mountain Drlg Co 6790 N Ventura Ave Ventura Calif
Roden & McRae Drlg Co Box 2286 Casper Wyo
Ross R Benton Inc 403 Robertson Bldg Wichita Falls Tex
Ross Dwight M Drlg Co 223 Hamilton Bldg Wichita Falls Tex
Rounds Don M Drlg Co Inc 925 Petroleum Club Bldg Denver 2 Colo
Rowan Drlg Co Inc Drawer 12247 Ft Worth 16 Tex
Rudy J W Box 684 Clay City Ill
Ruhl Drlg Co Inc 1621 Bk of Southwest Bldg Houston 2 Tex
Rushing A D Inc Box 232 Santa Paula Calif
Russell & Russell Drlg & Prod 621 Lindsay St Gainesville Tex
Rutledge Drlg Co Box 2239 Santa Fe N Mex
RWIT Drlg Co Box 551 Holdenville Okla

S

Sabre Drlg Co 222 Hughes Bldg Cushing Okla
Santa Fe Drlg Co Box 310 Whittier Calif
Santa Rosa Drlg Co Box 633 Apple Valley Calif
Schimmel Drlg Co 2121 Alamo Natl Bldg San Antonio Tex
Schlaikjer A L Box 761 Newcastle Wyo
Schoenfeld-Hunter-Kitch Drlg Co 812 Kennedy Bldg Tulsa 3 Okla
Scooter's Drlg Serv 437 Fortson Shreveport La
H F Sears 424 Petroleum Bldg Amarillo Tex
Seran & Howard Drlg Co Box 110 Okemah Okla
SeReBee Drlg Co Inc 521-22 Union Natl Bk Bldg Wichita Kans
Shaw-Hughes Drlg Co Box 1108 Bristow Okla
Sheets & Walton Drlg Co Box 152 Breckenridge Tex
Sherin Drlg Co Inc 1709 First Natl Bldg Oklahoma City Okla
Shulman Bros Box 191 Vandalia Ill
Signal Drlg & Expl Inc 415 Petroleum Club Bldg Tulsa Okla
Simpson C J Drlg Co P O Box 10345 Dallas 20 Tex
Simpson C R Drlg Co 2975 Wilshire Blvd Los Angeles 5 Calif
Sitton & Norton Drlg Co 406 Lubbock Natl Bk Bldg Lubbock Tex
Sikes-Burckhalter Drlg Co 300 Oil & Gas Bldg Wichita Falls Tex
Slape Don Drlg Co Box 432 Olney Ill
Slim Hole Ltd Box 2588 Wichita Falls Tex
Smiley Drlg Co Rt 1 Box 241 Moore Okla
Roy H Smith Drlg Co 1117 City Natl Bk Bldg Wichita Falls Tex
Sojourner Drlg Corp Box 679 Abilene Tex
Southeastern Drlg Corp 211 N Ervay St Dallas Tex
Southland Drlg Co 435 Milam Bldg San Antonio Tex
Sprecher J D Box 299 Casper Wyo
Steen Drlg Co 619 West Bldg Houston 2 Tex
Sterling Drlg Box 125 Sterling Colo (Box 127 Sterling Kansas)
Stewart & Gouger Drlg Co 505 Alamo Natl Bldg San Antonio 5 Tex
Stickle Drlg Co 1100 Bitting Bldg Wichita 2 Kansas
Stouder Drlg Co 208 SE Riverside Dr Evansville Ind
Sun Drlg Co The 2975 Wilshire Blvd Los Angeles 5 Calif
Sunflower Drlg Co Box 311 Eureka Kan
Sunnyland Contr Co Inc Box 388 Rayne La
Sutton Drlg Co Box 6446 San Antonio Tex
Symons Drlg Co 999 Houston Club Bldg Houston 2 Tex

T

T & O Drlg Co Box 461 Gainesville Tex
Temple Drlg Co Inc 320 Indiana Bank Bldg Evansville Ind
Terminal Drlg & Prod Co P O Box 607 Wilmington Calif
Texdrill Corp McClain-Williams Bldg Conroe Tex
Tex-Mex Drlg Co 1211 Fidelity Union Life Bldg Dallas Tex
Thomas & Duffield Drlg Co 809 Citizens Natl Bk Bldg Abilene Tex
Thompson Expl Drlg Co Box 1657 Lubbock Tex
Thrasher Drlg Co Inc 1602 Beck Bldg Shreveport La
Thunderbird Drlg Inc 712 Union Center Bldg Wichita 2 Kan
Trachta Drlg Co Box 67 Muenster Tex
Tradewinds Drlg Co National Bank of Tulsa Bldg Tulsa 3 Okla
Transit Corp 1516 Liberty Bk Bldg Oklahoma City Okla
Trio Drlg Co 3012 Nussbaumer St Dallas 26 Tex
Tri-Service Drlg Co Box 1785 Midland Tex

Triton Drlg Co Inc Box 22282 Houston 27 Tex
Troop Drlg Co Box 145 St Elmo Ill
Troup & Suttles Inc Box 356 Konawa Okla
True Drlg Co Drawer 1612 Casper Wyo
Two R Drlg Co Inc 712 South St Houma La

U

U & E Drlg Co Box 323 Sullivan Ind
Rip C Underwood 553 First Natl Bk Bldg Amarillo Tex
Unit Drlg Co Box 599 Bristow Okla
United Drlg Co 8750 Holloway Dr Los Angeles 46 Calif

V

V-T Drlg Co 711 Hulman Bldg Evansville Ind
A L & J N Varner 550 E N 21 St Abilene Tex
Viking Drlg Co 102 W Crockett St San Antonio 5 Tex
Virginia Drlg Co Inc 712 Brown Bldg Wichita 2 Kan
John W Voss Drlg Co Inc 1322 Highland Dr McAllen Tex

W

Wade Drlg Co Inc 813 Gulf Bldg Tulsa Okla
Wagner & Wyant Drlg Co Inc 414 Petroleum Bldg Amarillo Tex
Wakefield Earl F 515 Union Center Bldg Wichita Kans
Walters Drlg Co Inc 510 Orpheum Bldg Wichita Kans
Walters Drlg Co Inc 4114 McMillan Dallas 6 Tex
Walters Rusty Drlg Co Box 304 Bakersfield Calif
Walton Drlg Co Box 241 Fairfield Ill
Ward Tommy Drlg Co 2402 Liberty Bk Bldg Oklahoma City Okla
Ward Travis Drlg Co Box 711 Athens Tex
Warton Drlg Co Box 2807 Odessa Tex
Webster C B Drlg Co 609 San Jacinto Bldg Houston 2 Tex
Wegener Dick Drlg Co 1820 First Natl Bldg Oklahoma City Okla
Well Drillers Inc 2001 First City Natl Bk Bldg Houston Tex
Wentworth Claude Drlg Inc Box 588 Russell Kan
West Central Drlg Co 717 Citizens Bk Bldg Abilene Tex
Wes-Mor Drlg Inc Box 1169 Graham Tex
Western Serv Drlg Co Inc Box 1428 Odessa Tex
Wes-Tex Drlg Co Box 2058 Abilene Tex
Westfall Chester H Drlg Co 1612 First Natl Bk Bldg Tulsa Okla
Wheless Drlg Co Box 1746 Shreveport La
Wilson Drlg Co Box 933 Jackson 5 Miss
C R Winn Drlg Contr Box 331 Salem Ill
Wise W W Drlg Inc Box 297 Tyler Tex
WLB Drlg Co 6635 Chocolate Bayou Rd Houston 21 Tex
Woolf & Magee Inc Box 635 Tyler Tex

Y

Yarborough Drlg Co 735 Wilson Bldg Corpus Christi Tex
Yates S P Drlg Co 309 Carper Bldg Artesia N Mex
Young Marshall R Drlg Co Drawer 712 Brookhaven Miss

U. S. Contract ROTARY Drillings Rigs

Asterisk (*) indicates rig also available for workover.

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
ALABAMA						
Mobile County						
Zach Brooks Drlg Co	7	dsl	1350	Emsco J-1100	1350	14,000
Jett Drlg Co Inc	108	dsl	1250	80-B	1000	12,000
	110	dsl	1400	Brwstr N-95	1400	14,000
	111	dsl	2000	Natl 110	1500	15,000
Sumter County						
Offshore Co	14	dsl-gas	1150	Natl 125	900	15,000
Washington County						
Penrod Drlg Co	33	dsl	1500	Brwstr N-12-A	1725	18,000
ALASKA						
Bethel						
Rowan Drlg Co Inc	27	dsl	1010	Natl 125	1530	15,000
Cape Yakataga						
Clyde Hall Drlg Co Inc	9	dsl	2000	Natl 110	2000+	16,000
Kenai Peninsula						
Coastal Drlg Co	3	dsl	1000	Emsco A-800	1650	13,000
	4	gas	1000	Emsco GB-800	1050	12,000
	5	dsl	1950	Emsco GB-800	1300	14,000
	6	dsl	1050	Emsco 500	660	9,000
Rowan Drlg Co	29	gas-btne	1350	Natl 110	2025	16,000
ARKANSAS						
Lafayette County						
L & N Drlg Co	*1	btne	280	Brwstr N-3	160	3,500
Montgomery Drlg Co	2	gas-btne	415	Brwstr N-55	—	7,500
Miller County						
Butler-Johnson Inc	2	gas-btne	670	Brwstr N-55	670	8,500
Milton Crow Inc	*6	gas	700	Brwstr N-7	500	6,000
Saline County						
Walters Drlg Co Inc (Kansas)	3	gas	130	Mayhew	130	1,000
Walters Drlg Co Inc (Dallas)	4	gas	130	Mayhew 1000	130	600/2½"
	5	gas-btne	—	Mayhew	100	500
	8	gas	220	Mayhew 1000	220	600/2½"
	9	gaso	130	Mayhew 1000	130	800/2½"
Union County						
H F Hatcher & Son	2	gas-gaso	250	Crdwll S-350	225	5,500
M Houston Drlg Co	1	gas	700	Wisn Gnt	700	10,000
McGoldrick & Watson Drlg Co	1	btne	165	Brwstr N-3	145	4,000
CALIFORNIA						
(Undesignated)						
Camay Drlg Co	3	gas	1050	Natl 75	950	11,000
Newton Drlg Co	1	dsl	350	Ideco	350	4,000
	2	dsl	350	Ideco	350	5,000
	4	dsl	450	Emsco	350	6,000
Colusa County						
Brown Drlg Co	*4	dsl	1200	Natl 80-B	1200	12,500
	*6	dsl	1600	Natl 110	2400	16,000
	*7	dsl	900	Natl 50-CA	600	8,500
L & F Drlg Co	3	gas-dsl	1000	Natl 75	—	9,800
R B Montgomery Drlg Inc	*3	gas	1400	Natl 100	1050	12,000
	*5	gas	1300	Natl 75	1050	11,000
	*6	dsl	1000	Natl 75	600	10,000
Santa Fe Drlg Co	32	dsl	450	Ideco H-40	300	6,000
Fresno County						
Armstrong Fowler Inc	3	dsl	—	Wisn Mogul	—	5,000
John S Hagestad Drlg Co	*4	dsl	680	Ideco H-525	440	7,500
K L Kellogg & Sons	27	gas	2000	Natl 100	1050	13,000
Miller & York Inc	1	dsl	300	Frnks Gnt Clpr	225	4,000
	J	dsl	300	Hopper MTA	325	5,600/3½"DT 7,500
R B Montgomery Drlg Inc	*1	dsl	1617	Natl 130	1635	18,000
Rocket Drlg Co	1	gas-btne-prop	555	Emsco G-300	350	5,500
Glenn County						
Brown Drlg Co	*3	dsl	825	"Oilwell" 66	550	9,500
	*9	dsl	825	Natl 50-CA	500	9,000
Kern County						
Coastal Drlg Co	1	dsl	3000	Emsco J-1250	1920	16,000
	2	gas	1200	Emsco J-750	1320	11,000
Barnes Core Drlg Co	*D-6	dsl	450	Custom	450	5,500/3½"
	*D-11	dsl	225	Custom	225	3,000/3½"
H Davis & R H Thompson Co	1	dsl	350	Emsco G-300	350	6,000
Drlg & Prod Co	1	dsl	400	Crdwll	350	6,000
	2	dsl-gas-gaso	400	Crdwll O	432	6,000
Armstrong Fowler Inc	4	dsl	300	Natl T-12	250	5,000
Green & Dreblow Drlg Co	2	dsl	900	Wisn Gnt	600	9,000
John S Hagestad Drlg Co	*1	dsl	570	Emsco GB-350	400	7,000
	*3	dsl	625	Emsco GB-350	400	7,000
Clyde Hall Drlg Co Inc	5	gas-btne	1000	Emsco GB-800	1000	12,000
Haney & Williams Drlg Co	*3	gas	750	Natl 75	1050	10,000
	*5	gas	1500	Wisn Titan	1000	12,500
K L Kellogg & Sons	18	gas	925	Natl 50	650	7,000
	19	dsl	1200	Natl 75	790	9,500
	23	gas	2090	Natl 75	790	9,500
	25	dsl	1480	Natl 75	1480	9,500
	28	dsl	1350	Natl 100	1100	13,000
	33	gas	1750	Emsco GB-800	1050	12,000
	34	gas	2475	Natl 125	2475	16,000
Knight Drlg Co	2	dsl	1020	Natl 50-CA	720	9,000
L & F Drlg Co	2	dsl	500	Emsco GB-250	—	5,000
Lloyd Drlg Co	*1	dsl	250	Emsco GB-160	200	4,000
Miller & York Inc	A	dsl	550	Emsco GC-500	900	10,000
	C	dsl	550	Emsco GB-350	450	7,500
	F	dsl	550	Emsco GA-500	600	8,500
	G	dsl	300	Emsco G-36	300	5,500
	H	dsl	300	Emsco GA-250	300	5,500
R B Montgomery Drlg Inc	*2	gas	1350	Natl 110	2025	16,000
Rocky Mountain Drlg Co	9	gas	1500	Natl 125	1500	20,000
	10	dsl	1850	Emsco J-1000	1850	15 000
	14	gas	1500	Emsco J-1250	1500	20,000
Kings County						
Armstrong Fowler Inc	2	dsl	300	Natl T-12	250	3,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Los Angeles County						
Camay Drlg Co	1	gas	1750	Emsco J-1000	1750	13,000
	4	gas	1400	Emsco GA-500	650	8,500
	*5	gas	900	Natl 50	550	8,000
	6	gas	700	Natl 50	550	7,500
	8	gas	1900	Emsco A-800	1900	13,000
Haney & Williams Drlg Co	*1	dsl	300	Wlsn Gnt	300	5,000
	*2	gas	600	Natl 50	600	7,500
	*6	AC elec	800	Natl 75	1200	11,000
	B	dsl	1600	Natl 80	1600	13,000
Herley Supply Co Inc	*1	gas	600	Natl 50	400	6,500
Fred Johnson Drlg Co	1	gas	1071	Emsco J-1000	714	9,500
	3	gas	1500	Emsco J-1000	1125	12,000
	4	elec	800	Natl 50	450	7,500
Knight Drlg Co	3	gas	1450	Beth M-58	750	11,000
Santa Fe Drlg Co	25	gas	1200	Natl 55	900	10,000
	29	elec	1000	Natl 3410-½ FE	800	15,000
	45	gas	900	Natl 100	1350	12,000
C R Simpson Drlg Co	2	gas	700	Natl 50	520	8,000
The Sun Drlg Corp	1	gas	2430	Natl 125	2430	20,000
	*2	elec	850	Natl 110	500	11,000
	*4	elec	850	Natl 110	500	11,000
Terminal Drlg & Prod Co	*1	gas	990	Natl 50-A	700	8,500
	*4	gas	630	Ideco H-40-D	450	6,000
	*7	dsl	330	Howard Turner M-1000	120	2,500
	*8	dsl	480	Wlsn Mogul	350	5,000
Monterey County						
Barnes Core Drlg Co	*D-10	dsl	450	Custom	450	5,500/3½"
Orange County						
Camay Drlg Co	*8	gas	1900	Emsco A-800	1900	13,000
H Davis & R H Thompson Co	2	dsl	350	Emsco GA-250-T	350	6,000
C R Simpson Drlg Co	1	gas	700	Natl 50	432	7,000
Sacramento County						
Knight Drlg Co	1	dsl	1020	M-CSCO U-35D	500	8,000
Rusty Walters Drlg Co	1	dsl	360	Cooper D-50	360	6,000
	2	dsl	360	Wlsn Torcair	360	7,000
San Benito County						
John S Hagestad Drlg Co	*2	dsl	540	Ideco H-30-D	340	4,500
San Bernardino County						
Santa Rosa Drlg Co	1	prop-gas	155	—	285	2,000
San Joaquin County						
L & F Drlg Co	1	gas	300	Emsco GB-250	—	5,000
Santa Fe Drlg Co	3	gas	900	Emsco G-500	440	7,500
Santa Barbara County						
Haney & Williams Drlg Co	A	AC elec	1400	Natl 80-B	1200	13,000
	C	AC elec	1400	Natl 80-B	1200	13,000
A D Rushing Inc	5	gas	900	Natl 50	700	7,500
Santa Fe Drlg Co	28	gas	1200	Natl 80-B	1350	12,000
Solano County						
Camay Drlg Co	9	gas	2300	Natl 130	2300	20,000
Green & Dreblow Drlg Co	1	dsl	600	Wlsn Gnt	600	9,000
Sutter County						
Brown Drlg Co	*2	dsl	825	"Oilwell" 66	550	9,500
Ventura County						
Caldrill Inc	T	gas	1600	OWS 96	1700	18,000
	U	gas	1500	OWS 96	1800	18,000
Graham & Klassen Drlg Co Inc	2	gas	1400	Natl 75	1050	10,500
	3	gas	1500	Natl 75	1200	11,000
	4	gas	1400	Wlsn Titan	1050	11,000
Herley Supply Co Inc	*2	dsl	1000	Wlsn Titan	1000	10,000
K L Kellogg & Sons	29	gas	1370	Natl 75	700	9,500
	31	gas	1580	Natl 125	1050	16,000
	32	gas	1400	Natl 75	1050	9,500
	36	gas	2475	Natl 125	2475	16,000
Rocky Mountain Drlg Co	1	gas	1200	Natl 75	900	11,000
	2	gas	1200	Natl 75	900	11,000
	3	gas	1200	Natl 100	900	14,000
	4	gas-dsl	1550	"Oilwell" 96	1850	20,000
	5	gas	1850	"Oilwell" 96	1850	20,000
	6	gas	1550	Emsco J-1000	1550	15,000
	*7	gas	1200	Natl 100	1110	15,000
	8	gas	1400	Natl 125	1750	20,000
	12	gas	1850	Natl 125	1850	20,000
	13	gas	1550	Emsco J-1250	1550	20,000
	*15	gas	1200	Emsco J-750	900	11,000
A D Rushing Inc	1	dsl	525	Wlsn 42	380	6,000
	2	gas	1500	Ideco 7-11	1140	11,000
	3	gas	1200	Wlsn Trair Gnt	900	9,000
	4	gas	1200	Wlsn Trair Gnt	900	9,000
Santa Fe Drlg Co	26	gas	1200	Wlsn Titan	900	10,000
The Sun Drlg Corp	*3	dsl	1300	Natl 110	1950	16,000
	*5	gas	1530	Natl 110	1530	16,000

LEE C. MOORE
CORPORATION

MODERN
STEEL STRUCTURES
FOR THE
OIL INDUSTRY

Moore
TULSA — PITTSBURGH

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Terminal Drlg & Prod Co	6	dsl	1000	Emsco GC-500	750	10,000
	*17	dsl	480	Wisn Mogul	350	5,000
	*18	dsl	600	Ideco 525	600	8,000
United Drlg Co	*1	gas	450	Emsco	450	6,000
COLORADO						
(Undesignated)						
Calvert Drlg Inc	28	—	—	Natl 80-B	1650	12,500
Willard Pease Drlg Co	3	prop	—	Grdnr Den	600	9,000
Baca County						
Graham-Michaelis Drlg Co	6	dsl	275	Beth Breeze	175	4,000
	8	dsl	400	Crdwll D	400	5,000
Moran Bros Inc	15	gas	400	Natl T-20	390	6,000
Ft Morgan County						
B F Allison Drlg Co	2	gas	675	M-CSCO U-15	675	8,500
	4	gas	900	Natl 75	900	12,000
Garfield County						
Gardner Bros Drlg Co Inc	9	gas-btne	450	M-CSCO U-15	675	7,000
Jackson County						
Arapahoe Drlg Co	8	gas-btne	375	Natl T-32	375	6,000
Colorado & Western Drlg Co	2	dsl	600	Natl 50-A	600	8,000
LaPlata County						
Gardner Bros Drlg Co Inc	17	gas-btne	550	Natl 50-A	700	8,500
McClain County						
Kerr-McGee Oil Industries Inc	16	gas	790	Natl 100	1248	12,500
Mesa County						
Mountain States Drlg Co Inc	4	gas-dsl	600	Emsco GB-500	—	9,000
	6	dsl	600	Natl 50	—	7,500
Moffat County						
Camay Drlg Co Rocky Mt Div	1	gas	775	M-CSCO U-15	600	8,500
	6	dsl	260	Johnson	450	5,000
Kerr-McGee Oil Industries Inc	31	gas	1000	Natl 100	1680	15,000
Signal Drlg & Expl Inc	2	dsl	475	M-CSCO	500	7,500
Montezuma County						
Great Western Drlg Co	36	gas-gaso	320	M-CSCO U-15	675	7,500
Kerr-McGee Oil Industries Inc	4	gas	885	Natl 75	832	11,500
Moran Bros Inc	10	gas	600	Emsco GA-350	550	8,000
Montrose County						
Mountain States Drlg Co Inc	11	gas-dsl	1000	Natl 80-B	—	12,500
Morgan County						
Kimbark Expl Co	3	gas	300	M-CSCO U-35	350	5,500
Lewis Bros Inc	1	dsl	376	Crdwll J-450	476	7,500
Prowers County						
Moran Bros Inc	6	gas	900	Wisn Gnt	750	9,500
Rio Blanco County						
R L Manning Co	7	gas-btne	750	Emsco G-500	750	8,000
	12	gas-btne	650	Emsco GA-350	450	7,000
San Miguel County						
Arapahoe Drlg Co	6	gas-btne	1320	Natl 80-B	1320	14,000
Calvert Drlg Inc	29	dsl	1000	Natl 50-A	1000	10,000
Washington County						
Allison Drlg Co Inc	1	gas	450	T-32	450	7,000
	5	gas	450	Frnks 137	300	6,000
Garvey Drlg Co	12	dsl	300	Wisn Gnt	320	6,000/3½"
Don M Rounds Drlg Co Inc	*1	dsl	530	Natl 50	530	6,500
Weld County						
Lewis Bros Inc	2	btne	360	M-CSCO U-15	460	6,500
FLORIDA						
Collier County						
Rimrock Tidelands Inc	*20	dsl	675	Brwstr N-55	900	10,000
Rowan Drlg Co Inc	32	gas-btne	1200	Natl 100	1110	12,000
ILLINOIS						
Clay County						
Claypool Drlg Co	1	dsl	300	Natl T-12	185	3,500
Petro Drlg Co Inc	1	dsl	526	Brwstr N-4	365	6,500
J W Rudy	1	dsl	150	Natl T-20	185	5,000
	3	btne	130	—	4000	Crdwll K
	50	dsl	250	Natl 50	214	6,000
Shulman Bros	2	dsl	330	Crdwll L	—	3,500
Don Slape Drlg Co	5	btne	360	Natl T-12	260	4,500
Christian County						
U & E Drlg Co	*1	dsl	450	Frnks 4500	450	3,500
	*2	dsl	450	Natl T-12	450	4,500
Clinton County						
Conrey Drlg Co	1	gas	140	Wisn Super	140	2,000/3½"
	2	dsl	175	Wisn Super	175	2,500/3½"
Effingham County						
C R Winn Drlg Co	*2	dsl	225	Crdwll L	225	4,000
Fayette County						
Troop Drlg Co	1	dsl	—	Natl T-20	220	4,500
Franklin County						
C E Brehm Drlg & Prod	3	dsl	302	Brwstr N-45	302	6,000
Jefferson County						
Ted Lindsay	2	dsl	220	Natl T-16	220	5,000
Pep Drlg Co	1	dsl	425	Beth Breeze	300	5,000
	2	dsl	425	Ideco H-35	300	6,000
Lawrence County						
W L Dillier Inc	3	gas	—	Failing 2500	130	2,000
Harris Drlg Co	1	btne	195	Crdwll S	172	4,000
Gene Miller Inc	8	dsl	274	Natl T-12	155	2,200
Walton Drlg Co	1	gas	—	Failing 2500	—	2,000/3½"
Macon County						
W L Dillier Inc	4	gas	—	Failing 2500	130	2,000
Marion County						
Ted Lindsay	3	dsl	220	Ideco H-30	160	4,000
Richland County						
W L Dillier Inc	1	dsl	—	Natl T-12	212	3,000
	2	gas	—	Failing 2500	130	2,000
	5	dsl	—	Natl T-20	212	3,500
Woody Jones Drlg Co	1	dsl	240	M-CSCO U-34	230	4,500
Don Slape Drlg Co	2	dsl	240	M-CSCO U-34	230	4,500
	4	dsl	300	Brwstr N-4	245	4,500
Saline County						
Eakle & Holder Drlg Co	1	dsl	300	Brwstr N-4	200	5,500
Wayne County						
The Noah Petroleum Co	1	dsl	300	Brwstr N-4	300	5,500
White County						
Harris Drlg Co	3	dsl	285	Natl 50	285	8,500
Kendall-Davis Drlg Co Inc	2	dsl	300	Crdwll S	300	4,000
Shulman Bros	1	dsl	330	Crdwll S-350	—	5,500
INDIANA						
Cass County						
Stouder Drlg Co	*2	gas	210	Natl T-12	180	3,500
Gibson County						
Eakle & Holder Drlg Co	4	dsl	300	Natl T-20	300	5,500
Harris Drlg Co	2	dsl	285	Natl 50	285	8,500
Highland Oil Co Inc	—	gas	—	B Erie	—	—
Walton Drlg Co	2	gas	—	Failing 2500	—	2,000/3½"
Greene County						
Stouder Drlg Co	*1	gas	210	Natl 40	180	4,000
Posey County						
Calvert Drlg Co	12	dsl	260	Ideco H-30	260	4,500
Eakle & Holder Drlg Co	2	dsl	400	Emsco G-300	400	5,500
Kendall-Davis Drlg Co Inc	1	dsl	400	Wisn Mogul	300	4,000
Lohmann-Johnson Drlg Co Inc	7	dsl	300	Crdwll S	440	4,500
Spencer County						
Temple Drlg Co Inc	1	btne	—	B-Erie 24-L	—	1,800
IOWA						
Dallas County						
Kirby Oil Ind Inc—	—	dsl	400	Brwstr N-4	400	4,500
Mills County						
Kirby Oil Ind Inc	—	dsl	400	Mayhew 3000	200	3,000
KANSAS						
Barber County						
Thunderbird Drlg Inc	2	dsl	285	Natl T-32	285	5,500
Barton County						
Bennett & Roberts Drlg Co	*1	dsl	250	Emsco GB-250	250	5,000
Garvey Drlg Co	3	dsl	175	M-CSCO U-15	296	5,000
Quaker Drlg Co	2	dsl	350	M-CSCO U-15	—	5,000
Raymond Drlg Co	1	dsl	600	Wisn Mogul	600	4,000
Thunderbird Drlg Inc	1	btne	225	Crdwll S	225	4,500
Virginia Drlg Co Inc	*2	dsl	G D	Natl 50	400	7,000
Butler County						
Rex & Morris Drlg Co	1	dsl	260	Natl T-25	260	5,000
Cheyenne County						
John O Farmer Inc	*5	gas	400	Natl 50	450	6,500
Clark County						
Unit Drlg Co	*3	dsl	750	Natl 50-A	750	8,000
Earl F Wakefield	2	dsl	640	Wisn Gnt Rdair	640	8,500
Comanche County						
Holm Drlg Co	6	dsl	780	Wisn Gnt	600	8,000
Crawford County						
Walters Drlg Co Inc (Kansas)	2	gas	—	Mayhew	100	500
Ellis County						
Garvey Drlg Co	9	dsl	175	Wisn Gnt	296	5,000
Raymond Drlg Co	2	dsl	600	M-CSCO U-15	600	8,000
Transit Corp	3	dsl	280	Emsco	—	4,500
Finney County						
Garvey Drlg Co	15	dsl	175	Wisn Gnt	296	5,000
Sterling Drlg Co	*1	dsl	370	Emsco G-300	370	4,500
Earl F Wakefield	3	dsl	440	Wisn Gnt Rdair	440	6,000
Ford County						
Graham-Michaelis Drlg Co	3	dsl	300	Crdwll S	175	5,000
Graham County						
Empire Drlg Co (Kans)	1	dsl	300	Natl T-32	300	5,000
Hamilton County						
Earl F Wakefield	7	gas-btne	220	Emsco GB-160-T	250	4,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Harper County						
Gross Drlg Co	2	prop-btne	—	M-CSCO	250	5,000
Claude Wentworth Drlg Co Inc	*4	dsl	400	M-CSCO U-15	500	8,000
Hodgeman County						
Barnett Drlg Inc	5	dsl	265	Natl T-25	265	5,000
Garvey Drlg Co	10	dsl	175	Wisn Gnt	296	5,000
Kearney County						
Sterling Drlg Co	*6	dsl	440	M-CSCO U-15	440	6,500
Kingman County						
Garvey Drlg Co	11	dsl	175	Wisn Gnt	296	5,000
Pickrell Drlg Co	*1	dsl	450	M-CSCO U-15	450	5,500
Walters Drlg Co	*1	dsl	—	Natl 50	—	500
McPherson County						
SeRoBee Drlg Co Inc	*2	gas-btne	300	Crdwll RL	250	4,500
Marion County						
Barnett Drlg Inc	6	dsl	265	Natl T-25	265	5,000
Buick Drlg Inc	2	dsl	250	Wisn Gnt	325	5,000
Mallard Dirg Co Inc	*1	dsl	—	G-300	180	4,000
SeRoBee Drlg Co Inc	1	dsl	—	Crdwll K	150	—
Sunflower Drlg Co Inc	*1	dsl	175	Brwstr N-3	320	3,500
Meade County						
Bennett & Roberts Drlg Co	*2	dsl	250	Emsco 250	250	6,000/3½"
	*3	dsl	500	Emsco GA-500	500	8,000
Graham-Michaelis Drlg Co	4	dsl	500	M-CSCO U-15	500	7,000
Tradewinds Drlg Co	*56	gas-btne	—	M-CSCO U-15	700	8,500
Claude Wentworth Drlg Co Inc	*10	dsl	400	Emsco 500	500	8,000
Morton County						
Graham-Michaelis Drlg Co	1	dsl	275	Beth Twister	500	6,500
Holm Drlg Co	4	dsl	520	"Oilwell" 52-T	300	6,000
	5	dsl	440	"Oilwell" 52-T	300	6,000
Lohmann-Johnson Drlg Co Inc	3	btne	300	Natl 50	450	5,500
R W Rine Drlg Co	5	gas-btne	520	Brwstr N-55	550	8,500
Phillips County						
K & E Drlg Inc	*1	dsl	225	"Oilwell" 52-T	300	5,000
Rawlins County						
John O Farmer Inc	*3	gas	330	Guffy Spad	330	7,000
Murfin Drlg Co	3	dsl	300	Natl T-20	300	5,000
Claude Wentworth Drlg Co Inc	*2	gas-dsl	240	Crdwll "S"	175	5,000
	*5	dsl	400	M-CSCO U-15	500	8,000
Rice County						
Sterling Drlg Co	*4	gas	450	M-CSCO U-15	450	5,500
Rooks County						
Transit Corp	2	dsl	280	Emsco	—	4,500
	4	dsl	280	Emsco	212	4,500
Virginia Drlg Co Inc	*1	dsl	G D	Natl 32	400	5,000
Rush County						
John O Farmer Inc	*4	dsl	400	Ideco H-30	400	7,000
Russell County						
A L Jackson Drlg Co	1	dsl	285	M-CSCO U-15	285	6,000
Mast Drlg Inc	*2	dsl	185	Natl T-32	250	5,500
Scott County						
K & E Drlg Inc	*2	dsl	225	Natl T-20	300	5,000
Seward County						
D & M Drlg Co Inc	3	dsl	600	M-CSCO U-15	600	8,000
Garvey Drlg Co	22	dsl	300	Wisn Mogul 42	450	7,000
Moran Bros Inc	17	dsl	400	Wisn Gnt	400	6,000
R W Rine Drlg Co	2	dsl	520	Brwstr N-7	600	8,500
Sheridan County						
John O Farmer Inc	*1	gas	330	Guffy Spad	330	7,000
Stafford County						
Chief Drlg Co Inc	1	dsl	250	Emsco 300	300	5,000
Garvey Drlg Co	14	dsl	175	Wisn Gnt	296	5,000
Quaker Drlg Co	1	dsl	350	Wisn	—	5,000
Stevens County						
R W Rine Drlg Co	1	gas-btne	620	Brwstr N-35	600	8,500
Sumner County						
Garvey Drlg Co	8	dsl	175	Wisn Gnt	296	5,000
Pickrell Drlg Co	*10	dsl	270	Ideco H-40	270	6,000
Stickle Drlg Co	*4	dsl	300	Ideco H-35	300	5,000
Claude Wentworth Drlg Co Inc	*1	gas	200	Crdwll "S"	200	5,000
KENTUCKY						
(Undesignated)						
Marhill Oil & Gas Co Inc	1	dsl	—	"Oilwell"	—	5,000
Hopkins County						
Stouder Drlg Co	*3	dsl	160	Crdwll	160	2,000
Kenton County						
Moran Bros Inc	14	dsl	350	Natl T-12	350	4,500
Union County						
Big Seven Drlg Co	1	dsl	300	Emsco GB	300	4,500
Webster County						
Eakle & Holder Drlg Co	3	dsl	300	Ideco H-30	300	5,500
Temple Drlg Co Inc	*12	dsl	300	L C Moore	440	4,500
V-T Drlg Co	*1	dsl	—	Crdwll H	—	3,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
LOUISIANA						
(Undesignated)						
Circle Drlg Co Inc	Bge 6	dsl-elec	2300	Ideco E-2500	2750	20,000
The Power Rig Drlg Co Inc	Bge 7	dsl	1200	Emsco GB-800	—	15,000
Acadia Parish						
Clegg & Hunt	1	stm	—	Emsco 10	—	15,000
Comet Drlg Co	2	dsl	1000	Natl 75	900	10,000
	4	dsl	750	Brwstr N-7	600	10,000
Delta Drlg Co	21	gas-btne	800	Natl 75	650	9,500
Mac Drlg Co	3	stm	600	Natl 23-9-FE	1000+	20,000
Owen Drlg Co	9	stm	1000	Ideco Big Gnt	1000	16,000
Ruhl Drlg Co Inc	*1	gas-btne	645	Brwstr N-7	675	9,500
Sunnyland Contr Co Inc	*8	gas-gaso	—	Crdwll D	312	8,000
Fred Wilson Drlg Co	8	gas	1600	Natl 110	1200	16,000
Ascension Parish						
The Power Rig Drlg Co Inc	3	gas-btne	1000	Emsco A-800	—	13,000
Assumption Parish						
Brewster-Bartle Drlg Co Inc	14	dsl	—	Natl 125	—	16,000
Circle Drlg Co Inc	7	gas-btne	1500	Ideco 7-11	1200	15,000
Clegg & Hunt	8	dsl	—	—	1275	18,000
Gracey-Hellums Corp	Bge 2	stm	1200	Natl 23-9-FE	1200	15,000
The Power Rig Drlg Co Inc	8	gas-btne	1500	Ideco 7-11	—	15,000
Rowan Drlg Co Inc	30	dsl	1545	Emsco A-1500	1545	20,000
Baton Rouge Parish						
Offshore Co	17	gas	1850	Natl 125	900	15,000
Beauregard Parish						
Penrod Drlg Co	2	gas-btne	500	Brwstr N-45	550	6,500
Prince Marine Drlg & Expl Co	6	gas-btne	1400	"Oilwell" 76	1200	13,000
Bienville Parish						
Milton Crow Inc	*5	dsl	900	Brwstr N-75	850	11,000
Montgomery Drlg Co	1	gas-btne	700	Emsco GA-500	600	9,500
Penrod Drlg Co	76	gas-btne	1250	M-CSCO U-20	1400	14,000
Thrasher Drlg Co Inc	1	gas-btne	600	M-CSCO U-15	700	8,500
Caddo Parish						
Arrow Drlg Co	16	Natl 125	840	Emsco	1050	12,000
Butler-Johnson Inc	4	gas-btne	500	Brwstr N-4	350	6,500
Barnwell Drlg Co Inc	34	dsl	800	M-CSCO U-34	500	7,000

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JET-LUBE INC

3093 NO. CALIFORNIA ST. BURBANK, CALIF.

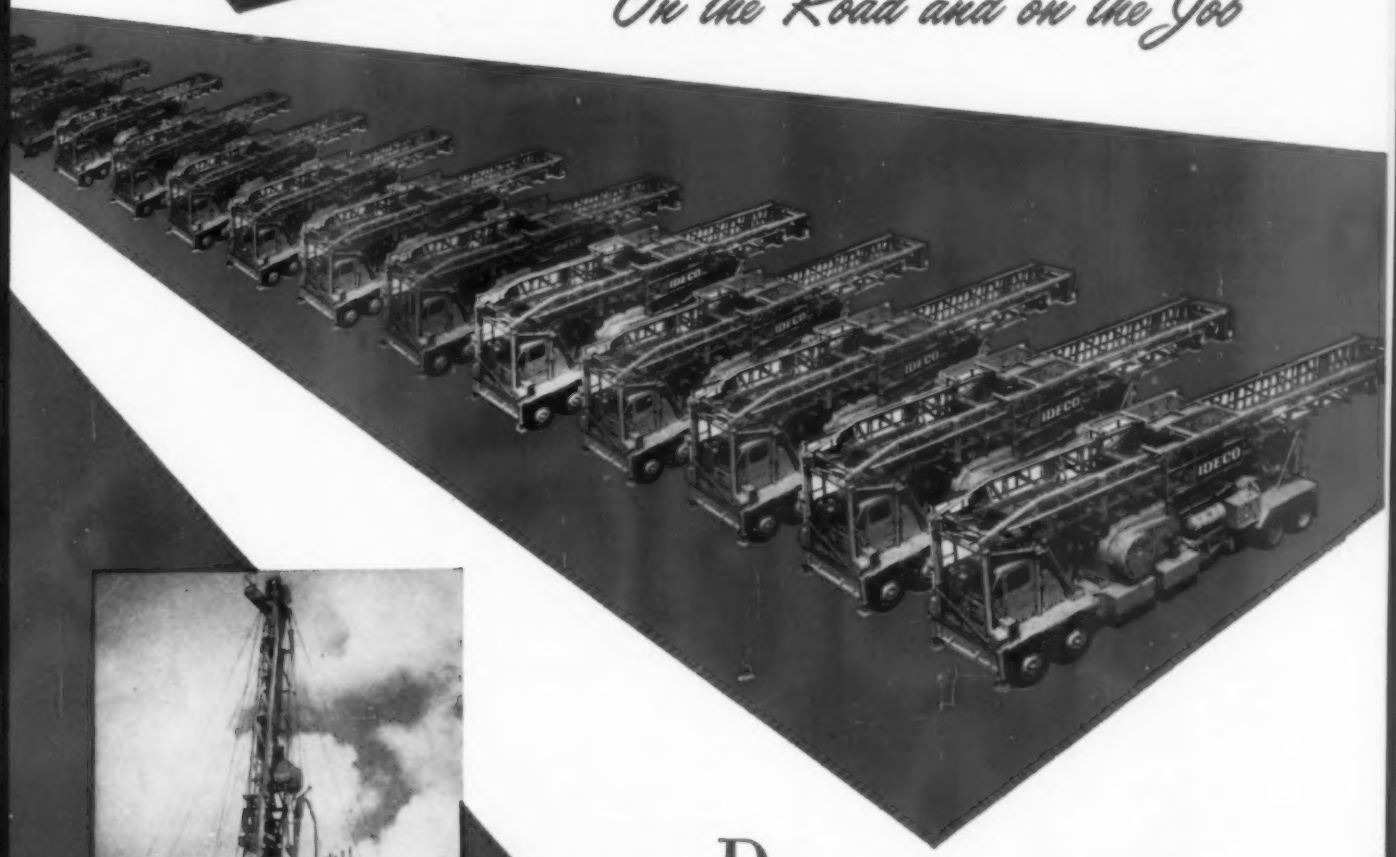
EXPORT OFFICE: 30 Rockefeller Plaza, New York 20, N.Y.

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Gary Drlg Co	2	btne	145	6-MO-893	118	2,500
	3	btne	170	Brwstr N-S	165	10,000
Milton Crow Inc	*3	dsl	800	Brwstr N-7	600	8,000
	4	gas	900	Brwstr N-75	750	11,000
L & N Drlg Co	*2	btne	280	Wisn Super	120	2,500
Lunsford Drlg Co	1	LPG	185	Brwstr N-3	145	4,000
	2	LPG	145	Wisn Spr	145	2,500
Caldwell Parish						
Arrow Drlg Co	18	gas	1260	Emsco 1250	1575	15,000
Cameron Parish						
Brewster-Bartle Drlg Co Inc	12	dsl	—	"Oilwell" 96	1500	16,000
Delta Drlg Co	14	stm	900	Ideco Big Gnt	1690	15,000
	20	gas-btne	1520	Emsco J-1250	1250	15,000
Dixie Drlg Co Inc	2	dsl	2000	Beth Tornado	1500	16,000
Harry Edwards Drlg Co	Bge 1	dsl	600	Natl 75	800	10,000
	Bge 12	dsl-elec	3000	Ideco Big Gnt	3000	20,000
A W Eggleston Inc	*4	gas-btne	550	Natl 60-A	750	10,000
Kilroy Drlg & Prod Co	4	gas	1100	Ideco 7-11	1125	12,000
Owen Drlg Co	5	gas	1000	Natl 75	1000	12,000
Prince Marine Drlg & Expl Co	4	btne	1800	Emsco J-1100	1400+	15,000
	8	gas-btne	650	"Oilwell" 96 U-15	700	9,000
Symons Drlg Co	U-15	gas	750	M-CSCO U-15	750	11,500
C B Webster Drlg Co	4	stm	1200	Natl FE-34-10	1200+	15,000
Wheless Drlg Co	Bge 12	gas-btne	1065	Natl 80	1300	12,000
Fred Wilson Drlg Co	10	gas	1050	Natl 55	800	10,500
Catahoula Parish						
Dorris Ballew Inc	6	dsl	380	M-CSCO U-15	600	7,500
McGoldrick & Watson Drlg Co	3	dsl	300	500-DW Spencer	250	5,000
Claiborne Parish						
Maritzky & Bibby	1	gas	330	Brwstr	185	5,000
	2	gas	330	Crdwll	145	3,000
Scooter's Drlg Serv	3	dsl	600	Brwstr N-55	600	6,000
Wheless Drlg Co	10	gas-btne	1020	Natl 100	1200	13,000
Concordia Parish						
J B Fletcher Drlg Co	1	gas-btne	—	M-CSCO U-15	600	7,500
Jett Drlg Co Inc	112	dsl	1200	Brwstr 55	800	9,000
Marlin Expl Inc	*4	dsl	—	M-CSCO U-14	600	8,000
Scooter's Drlg Serv	4	dsl	300	Brwstr N-45	500	6,000
Evangeline Parish						
Harris Drlg Co Inc	5	gas	—	Crdwll K	—	12,000
Owen Drlg Co	8	dsl	1040	Natl 50	1040	10,000
Franklin Parish						
Wheless Drlg Co	1	gas-btne	510	Brwstr N-45	450	7,500
Iberia Parish						
Delta Drlg Co	19	stm	1200	Natl 34-10-FE	1690	15,000
Eilers Drlg Co	*2	gas-btne	350	M-CSCO U-10	380	7,600
Wheless Drlg Co	4	stm	1000+	Emsco UBLS-54	1000+	12,000
Iberville Parish						
Circle Drlg Co Inc	5	gas-btne	1500	Brwstr N-12	1440	15,000
Delta Drlg Co	37	dsl	900	Beth MC-950	1400	15,000
Jackson Parish						
Barnwell Drlg Co Inc	7	dsl	800	Brwstr N-75	800	12,000
	9	gas	1800	Brwstr N-95	1800	20,000
	11	dsl	1200	Brwstr N-85	1200	13,000
Woolf & Magee Inc	7	gas-btne	800	Beth MC-450	800	11,000
Jefferson Parish						
Delta Drlg Co	45	stm	—	Emsco UH-54	1000	15,000
Rowan Drlg Co Inc	Bge 21	dsl-elec	1000	Emsco ECA	1920	12,000
	Bge 26	dsl	1325	Natl 100	1545	14,000
Sea Drlg Corp	*5	dsl	2500	M-CSCO	2500	18,000
Two-R Drlg Co Inc	1	dsl	300	Beth B-3661	300	25,000
Wheless Drlg Co	Bge 6	gas-btne	1000	Wisn Titan	1200	12,000
Jefferson Davis Parish						
Circle Drlg Co Inc	3	gas-elec	2500	Ideco Big Gnt	2100	15,000
Clegg & Hunt	3	dsl	—	Wisn Titan 56	800	11,500
Delta Drlg Co	5	gas-btne	900	Natl 100	800	12,000
Harry Edwards Drlg Co	6	stm	350	BIW 12	4-150# Boilers	16,500
	7	stm	350	BIW 12	4-150# Boilers	16,500
Harris Drlg Co Inc	3	gas	—	Crdwll R	185	12,000
Steen Drlg Co	2	stm	600	Emsco ECA	—	16,000
Fred Wilson Drlg Co	9	gas	1400	Natl 80-B	800	12,500
Lafayette Parish						
B M Hester	1	btne	325	Natl T-20	200	6,000
Owen Drlg Co	4	stm	1000	Emsco UBLS-54	—	14,000
Penrod Drlg Co	11	dsl	2200	Brwstr N-95	1400	13,500
Slim Hole Ltd	1	btne	325	M-CSCO	200	6,000
	1	btne	325	Wisn Mogul	200	6,000
C B Webster Drlg Co	7	stm	1600	Emsco ECA-10½	1200+	15,000
Fred Wilson Drlg Co	7	gas	1400	Natl 80-B	800	12,500
Lafourche Parish						
Crawford Drlg Co	2	stm	1000	ECA Emsco	1000	15,000
Delta Drlg Co	35	gas-btne	1200	Emsco J-1100	1200	15,000
	47	dsl	1700	Ideco PR-1050	1560	14,000
	*3	dsl	1200	Beth AC-702	1500	15,000
Dixie Drlg Co Inc	4	dsl	1500	Beth 1013	1500	16,000
The Grande Corp	7	stm	—	Emsco	600	15,500
	8	stm	—	Alco BIW DNT-12	500	17,250
Kelly Drlg Co Inc	3	pwr	1850	"Oilwell" 96	1500	18,000
Offshore Co	Bge 20	dsl-gas	900	Natl 125	900	15,000
	21	dsl-elec	2000	Natl U-34-10-FE	2000	20,000
	24	dsl-elec	2000	Natl 130-E	2000	20,000
	25	dsl-elec	2000	Natl 130-E	2000	20,000
Norton Drlg Co	Bge 4	dsl	1600	Emsco 1500	1600	17,000
	Bge 6	dsl	1400	Emsco 1500	1200	17,000
Rimrock Tidelands Inc	14	dsl	2000	Emsco A-1500	2000	20,000
Rowan Drlg Co Inc	Bge 1	dsl-elec	1600	Emsco ECA	2475	18,000
	Bge 3	dsl-elec	2150	Emsco EDA	3455	20,000
Wheless Drlg Co	Bge 11	gas-btne	1085	Emsco J-1250	1400	13,500
Lincoln Parish						
J B Fletcher Drlg Co	3	gas-btne	700	Brwstr N-7	—	8,500
Pyburn Drlg Co	2	gas	250	Wisn	800	9,000
Wheless Drlg Co	13	gas-btne	820	Emsco J-750	850	10,500
Madison Parish						
Pyburn Drlg Co	1	dsl	560	Ideco M-750	600	9,000
Orleans Parish						
Dixie Drlg Co Inc	3	dsl	3300	Beth B-3661	3000	16,000
Plaquemines Parish						
Brewster-Bartle Offshore Co	3	dsl	—	"Oilwell" 96	1500	16,000
	10	dsl	—	"Oilwell" 76	—	11,000
	11	dsl	—	"Oilwell" 96	1500	16,000
Clegg & Hunt	Bge 11	dsl-elec	2600	Ideco 2500	1900	25,000
Continental Rigs Inc	3	dsl	1800	Ideco M-1	1800	13,000
	*6	dsl	800	Emsco GB-500	800	9,000
Dillard-Waltermire Inc	8	stm	1200	Natl 34-10FE	1500	16,000
Offshore Co	12	dsl-elec	1500	Natl 110	1500	15,000
	22	dsl-elec	1500	Natl 130	1500	15,000
Penrod Drlg Co	Bge 40	dsl	2000	Brwstr N-12-A	1725	18,000
	Bge 41	dsl	950	Emsco J-1100	1100	14,000
Producers Drlg Co Inc	*1	dsl	2400	M-CSCO U-1220	2400	20,000
Rebstock & Reeves Drlg Co	*Bundy	dsl	1500	Wisn Titan	1500	12,000
Rowan Drlg Co Inc	Bge 18	stm	1800	Emsco ED	750	18,000
Sunnyland Contr Co Inc	*9	dsl	—	Crdwll D	450	8,000
Wheless Drlg Co	Bge 9	dsl	1700	Natl 130	1470	18,000
	Bge 15	dsl	1975	Natl 130	1900	18,000
Ouachita Parish						
Dixilyn Drlg Corp	7	dsl	2475	Natl 110	2475	15,000
H & S Drlg Co	*1	gas-btne	1235	Wisn Titan	700	12,000
	*2	gas-btne	1324	Brwstr N-95	700	14,000
Wheless Drlg Co	2	gas-btne	770	Brwstr N-7	800	9,500
Richland Parish						
Butler-Johnson Inc	1	gas-btne	650	Brwstr N-75	1005	12,000
Montgomery Drlg Co	3	gas-btne	225	Crdwll S	200	5,000
St. Charles Parish						
Offshore Co	Bge 16	dsl-gas	1350	Natl 125	1200	15,000
St. James Parish						
Continental Rigs Inc	*5	dsl	3000	Emsco EDA	3000	20,000
St. Landry Parish						
Pernie Bailey	1	gas	650	Brwstr N-75	—	11,000
	2	gas	800	M-CSCO U-40	—	11,000
Circle Drlg Co Inc	8	gas-btne	1200	M-CSCO U-20	1500	13,000
Delta Drlg Co	31	gas-btne	1020	Emsco J-1000	1260	13,000
A W Eggleston Inc	2	gas-btne	900	Ideco PR-800	900	12,000
Offshore Co	Bge 15	dsl	1365	Natl 125	1200	15,000
Fred Wilson Drlg Co	11	gas	1050	Natl 55	800	10,500
St. Martin Parish						
Offshore Co	*11	gas	800	Natl 50-F1	500	10,000
The Power Rig Drlg Co Inc	4	gas-btne	700	M-CSCO U-15	—	10,000
Rowan Drlg Co Inc	4	gas-btne	900	Natl 75	1149	11,000
C B Webster Drlg Co	1	dsl	1650	"Oilwell" 96	1800	17,000
St. Mary Parish						
Brewster-Bartle Offshore Co	1	dsl	—	"Oilwell" 96	1500	16,000
	2	dsl	—	"Oilwell" 96	1500	16,000
	6	dsl	—	"Oilwell" 96	1500	—
	8	dsl	—	"Oilwell" 96	1500	16,000
	15	gas	—	Emsco	—	10,000
Continental Rigs Inc	8	dsl	2200	Beth 1013	2200	20,000
A W Eggleston Inc	1	gas-btne	800	Ideco PR-800	700	11,000
	3	dsl	1500	Ideco PR-1050	1500	14,000
Gracey-Hellums Corp	Bge 4	dsl	1775	Emsco A-1500	1900	20,000
Norton Drlg Co	Bge 5	dsl	1600	"Oilwell" 96	1600	17,000
Offshore Co	8	dsl	1450	Natl 125	1200	15,500
	9	dsl	1000	Natl 75	1000	12,000
	19	gas	900	Natl 75	900	11,000

IDECO Drive-In Ramblers

BREAK THROUGH THE DOWNTIME BARRIER!

On the Road and on the Job



Ideco Dual Speed System in operation on a Drive-In Rambler Rig equipped with a 65-ft. Kwik-Lift Mast.

Do you want to reduce your downtime and increase your profits? If so, have a good look at an Ideco Drive-In Rambler Rig. You'll find that Drive-Ins are most in demand wherever they are. Six Drive-In Models, ranging from 114 to 395 horsepower, are available for every job from "pulling rods" to "slim-hole" drilling. These rugged self-propelled rigs are famous for their ease and economy of operation. Same rugged engine, torque converter and transmission used for hoisting . . . also power the rig on the road. The forward-mounted Ideco Kwik-Lift Mast travels rigged-up. Hydraulically-raised and telescoped, the mast can be ready for operation in minutes. Ask your Ideco man for full details!

There is no Substitute for Quality

IDECO P. O. BOX 1331 DALLAS, TEXAS

DRESSER INDUSTRIES, INC.
OIL • GAS • CHEMICAL • ELECTRONIC

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Owen Drlg Co	7	stm	1000+	Emsco	1000	16,000
Penrod Drlg Co	16	gas-btne	1825	Emsco J-1400	1650	18,000
	17	gas-btne	1450	Brwstr N-12-A	1650	18,000
Prince Marine Drlg & Expl Co	1	dsl	1750	"Oilwell" 96	1200	15,000
Producers Drlg Co Inc	3	dsl-elec	2600	Ideal	1200	20,000
Rimrock Tidelands Inc	15	dsl	2000	Brwstr N-12-A	2000	20,000
Rowan Drlg Co Inc	Bge 13	dsl-elec	1700	Emsco FCA	2700	18,000
C B Webster Drlg Co	3	gas	1250	Emsco J-1250	1300	15,000
Wheless Drlg Co	Bge 14	dsl	1700	Emsco J-1400	1470	18,000
Sabine Parish						
Hilburn Industries Inc	2	gas	550	Wisn	550	10,000
Terrebonne Parish						
Brewster-Bartle Drlg Co Inc	5	dsl	—	"Oilwell" 96	1500	16,000
	7	dsl	—	"Oilwell" 96	1500	16,000
Crawford Drlg Co	*1	dsl	500	Brwstr N-7	500	9,000
Delta Drlg Co	17	gas-btne	1020	Emsco J-1100	1300	15,000
	25	gas-btne	1520	Emsco J-1250	1250	15,000
	32	stm	1200	Ideco Big Gnt	1690	15,000
Delta Marine Drlg Co	*4	dsl-elec	2500	Emsco EDA	1400	15,000
Gracey-Hellums Corp	Bge 5	dsl	1775	Emsco A-15C0	1900	20,000
Jett Drlg Co Inc	Mr Kemp	dsl	2000	Grdnr-Denver	2100	30,000
Kelly Drlg Co Inc	1	stm	1200	Ideco Jr Gnt	1500	15,000
	2	pwr	1200	"Oilwell" 96	1500	18,000
Kilroy Drlg & Prod Co	1	gas	1200	"Oilwell" 96	1350	15,000
Norton Drlg Co	Bge 3	stm	1200+	Natl 34-62	1500	17,000
Owen Drlg Co	3	gas	900	Brwstr N-95	—	15,000
Penrod Drlg Co	6	dsl	2000	Natl 110	1350	16,500
	15	dsl	2000	GD-2100	2200	25,000
	Bge 46	dsl-elec	2500	Emsco ECB	1250	20,000
	Bge 47	dsl-elec	2500	Emsco EDA	1250	20,000
Producers Drlg Co Inc	*2	dsl	2200	M-CSCO U-914B	1800	18,000
Rowan Drlg Co Inc	Bge 6	dsl-elec	1200	Emsco ED	2800	18,000
	Bge 14	dsl-elec	1600	Emsco ECA	2325	18,000
Southeastern Drlg Co	Bge 9	—	2200	"Oilwell" 96	2200	16,000
	Bge 14	—	1600	"Oilwell" 96	1600	16,000
C B Webster Drlg Co	8	stm	1600	Natl FE-23-10½	1200+	15,000
	Bge 9	dsl	1850	Emsco J-1400	2200	17,000
Wheless Drlg Co	5	dsl	2150	Emsco J-1400	1575	18,000
	Bge 7	dsl	2000	Natl 130	1900	18,000
	Bge 8	dsl	1700	Natl 130	1900	18,000
Union Parish						
Hydro Drlg Co Inc	1	gas	200	Bunn 1 Hy	300	2,800
Vermilion Parish						
Circle Drlg Co Inc	4	gas-btne	800	Brwstr N-75	960	11,000
Dillard-Waltermire Inc	6	stm	1200	Natl 34-10FE	1500	16,000
Dixie Drlg Co Inc	1	dsl	1500	Beth 1013	1500	16,000
Owen Drlg Co	1	stm	540	Ideco Big Gnt	—	15,000
Penrod Drlg Co	14	dsl	2200	Brwstr N-12-A	1800	18,000
The Power Rig Drlg Co Inc	10	dsl	2250	Emsco A-1500	2000	25,000
Prince Marine Drlg & Expl Co	7	btne	800	"Oilwell" 76	1050	12,500
C B Webster Drlg Co	Bge 6	dsl	2000	Emsco J-1400	2400	17,000
Fred Wilson Drlg Co	12	gas	1400	Natl 110	1200	16,000
Washington Parish						
Eilers Drlg Co	3	gas-btne	400	M-CSCO U-15	500	10,000
Webster Parish						
Barnwell Drlg Co Inc	4	gas	800	Brwstr N-7	800	10,000
	45	dsl	800	Brwstr N-45M	650	8,000
J B Fletcher Drlg Co	2	gas-btne	370	Brwstr N-4	—	6,500
Wheless Drlg Co	3	gas-btne	575	Emsco GB-350	450	7,500
Woolf & Magee Inc	1	stm	1000	Natl 34-10FE	1200	15,000
Winn Parish						
Gary Drlg Co	1	btne	145	Hercules WXLC-3	63	1,600
MICHIGAN						
Allegan County						
Bernhardt Drlg Co	1	dsl	300	Failing 2500	300	3,500/2⅞"
Calvert Drlg Inc	8	dsl	260	Ideco H-30	190	4,500
Calhoun County						
Gene Miller Inc	7	dsl	435	Brwstr N-4	302	5,500
	9	dsl	541	Natl T-50	541	9,000
Hillsdale County						
Hack Drlg Co	2	btne	—	Beth S-50	161	4,500
Ingham County						
Sabre Drlg Co	2	dsl	330	M-CSCO U-34	300	5,000/4"
Iosco County						
Graves & Meching Inc	1	—	—	B Erie 36-L	—	—
	1	—	—	B Erie 36-L	—	—
Jackson County						
Midwestern Drlrs Inc	3	dsl	370	M-CSCO U-15	750	8,500
Newaygo County						
Hack Drlg Co	3	btne	—	M-CSCO U-15	412	8,500
St. Clair County						
Graves & Meching Inc	1	—	—	B Erie 48-L	—	—
Sanilac County						
Calvert Drlg Inc	11	dsl	260	Natl T-32	190	6,000
	21	dsl	350	Ideco H-35	260	6,500/4"
MISSISSIPPI						
Adams County						
Jett Drlg Co Inc	107	dsl	600	Brwstr N-45	400	7,000
Marlin Expl Inc	1	gas	—	Brwstr N-75	750	10,000
Rimrock Tidelands Inc	*21	dsl	500	Emsco GB-500	600	10,000
Sunnyland Contr Co Inc	7	dsl	—	Ideco H-40	450	8,000
Woolf & Magee Inc	10	gas-btne	275	Beth Breeze	275	10,000/2⅞"
Amite County						
Dorris Ballew Inc	2	dsl	760	Wisn Titan	1300	12,500
Cook Drlg Co	18	gas	750	Wisn Atlas	750	11,500
Brookhaven County						
Marshall R Young Drlg Co	6	stm	1688	Natl 34	1480	16,000
	7	stm	1688	Natl 34	1480	16,000
Clay County						
Cook Drlg Co	16	gas	1125	Wisn Titan	1125	12,500
Copiah County						
Arrow Drlg Co	17	gas	1260	Emsco 1250	1575	15,000
Dixilyn Drlg Corp	5	gas	950	Natl 100	950	14,000
Franklin County						
Cook Drlg Co	22	gas	375	Wisn Spr Mogul	450	10,000
Marshall R Young Drlg Co	1	—	900	Natl 75	648	11,500
Sunnyland Contr Co Inc	12	dsl	1120	Ideco H-525	1000	10,000
Woolf & Magee Inc	12	gas-btne	275	Beth S-45	275	10,000/2⅞"
Hancock County						
Marshall R Young Drlg Co	12	—	740	Natl 50-A	558	10,000
Hinds County						
Jett Drlg Co Inc	115	dsl	1250	Natl 80-B	1000	12,000
Marshall R Young Drlg Co	11	—	1350	Wisn Titan	1122	14,000
Jasper County						
Cook Drlg Co	23	gas	1300	Wisn Spr Titan	1300	15,000
Larco Drlg Co	4	dsl	1250	"Oilwell" 96	1800	16,000
Rimrock Tidelands Inc	10	gas-btne	1400	Natl 110	1900	15,000
Woolf & Magee Inc	11	gas-btne	275	Beth S-45	275	10,000/2⅞"
Jefferson County						
Dixilyn Drlg Corp	6	dsl	2490	Natl 130	2490	16,000
Jones County						
Big Chief Drlg Co	2	gas	1875	Natl 125	1815	16,000
Zach Brooks Drlg Co	4	gas	1350	Brwstr N-75	1350	12,000
	8	gas	2600	Brwstr N-12	2600	18,000
	9	gas-btne	1350	Brwstr N-95	1350	14,000
Lamar County						
Marshall R Young Drlg Co	8	—	1350	Wisn Titan	1122	14,000
Lincoln County						
Dixilyn Drlg Corp	1	gas	1050	Natl 75	1050	12,000/3½"
Empire Drlg Co	*3	gas	550	Brwstr N-75	1050	12,000
Marshall R Young Drlg Co	5	—	1350	Wisn Titan	1122	14,000
Marion County						
Arrow Drlg Co	22	dsl	1200	Emsco 1250	1575	15,000
Empire Drlg Co	7	gas	650	Wisn Titan	1050	15,000
Woolf & Magee Inc	5	gas-btne	800	Beth MC-450	800	11,000
Pearl County						
Larco Drlg Co	5	gas	700	"Oilwell" 76	1000	11,000
Perry County						
Cook Drlg Co	20	gas	1125	Wisn Titan	1125	12,500
Pike County						
Dorris Ballew Inc	8	dsl	1380	Natl 125	1725	16,000
FWA Drlg Co Inc	5	—	—	—	—	12,000
Larco Drlg Co	7	gas	1100	"Oilwell" 96	1100	14,000
Sunnyland Contr Co Inc	14	dsl	1800	Beth Tornado	1200	16,000
	11	dsl	—	Ideco H-750	520	11,000
Marshall R Young Drlg Co	3	—	900	Natl 75	830	11,500
Rankin County						
Larco Drlg Co	2	dsl	1200	"Oilwell" 96	1200	14,000
Simpson County						
Larco Drlg Co	6	dsl	1500	"Oilwell" 96	1800	16,000
Smith County						
Rimrock Tidelands Inc	11	gas-btne	1325	M-CSCO U-20	1900	20,000
	19	dsl	1410	Beth MC-950	1200	18,000
Woolf & Magee Inc	8	gas-btne	1300	Beth Tornado	1300	15,000
Walthall County						
Arrow Drlg Co	1	gas	—	Beth 810	1050	12,000
	24	dsl	1200	Emsco 1250	1500	15,000
Jett Drlg Co Inc	105	dsl	600	Natl T-32	500	8,000
	106	dsl	1600	Brwstr N-95	1400	13,000
Larco Drlg Co	8	gas	1200	Natl 110	1500	15,000
Rimrock Tidelands Inc	8	dsl	1000	Brwstr N-75	900	11,000
Wayne County						
Cook Drlg Co	19	gas	1125	Wisn Titan	1125	12,500
Rimrock Tidelands Inc	12	gas-btne	1000	Natl 75	1215	12,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Avail-able to Drwwks	Rated Depth with 4½" Pipe
Wilkinson County						
Dorris Ballew Inc	4	dsl	760	U-914C	1900	15,000
Yazoo County						
Big Chief Drlg Co	34	dsl-elec	2560	Emsco EDA-460	1600	18,000
Rowan Drlg Co Inc	8	gas-btne	1920	Natl 125	1920	18,000
MISSOURI						
Holt County						
Nemaha Oil Co	1	dsl	370	Frnks SAL-3000	370	4,500/3½
MONTANA						
Big Horn County						
Great Northern Drlg Co	5	dsl	450	Crdwll D	450	7,500
Fallon County						
Helmerich & Payne Inc	8	gas	600	Natl 55	800	9,000
Roden & McRae Drlg Corp	4	dsl	900	Emsco GB-800	900	12,500
Signal Drlg & Expl Inc	1	gas	800	M-CSCO	900	10,000
Fergus County						
Great Northern Drlg Co Inc	1	dsl	300	N-4 Brwstr	300	6,000
Glacier County						
Great Northern Drlg Co Inc	2	dsl	300	Crdwll	300	6,000
Kullberg & Otthouse Inc	1	dsl	550	M-CSCO U-15	550	7,500
Mountain States Drlg Co Inc	9	gas-dsl	1400	Natl 125	—	15,000
Musselshell County						
Fitzpatrick Drlg Co Inc	7	dsl	350	Ideco HB-30-SC	350	5,000
Hose-Austin Drlg Corp	3	gas	450	M-CSCO U-15	550	7,000
	4	gas	500	Emsco GB-350	588	7,500
Powder River County						
Roden & McRae Drlg Corp	*2	dsl	265	Emsco GA-300	270	4,500
Tradewinds Drlg Co	2	dsl	—	Emsco GA-300	274	6,000
Prairie County						
Zach Brooks Drlg Co	6	dsl	1300	Brwstr N-75	1300	12,500
Roosevelt County						
Calvert Drlg Inc	26	gas-btne	1380	Natl 80-B	1380	14,000
Great Northern Drlg Co Inc	3	dsl	600	M-CSCO U-15	600	9,000
Rowan Drlg Co Inc	23	gas-btne	1140	Natl 75	1503	11,000
Signal Drlg & Expl Inc	7	dsl	250	Beth S-55	600	8,000
Tradewinds Drlg Co	8	gas-btne	—	M-CSCO U-15	700	8,500
Rosebud County						
Fitzpatrick Drlg Co Inc	2	dsl	500	M-CSCO U-22	500	6,500
True Drlg Co	*4	gas-LPG	650	Emsco 250	400	6,000
Stillwater County						
Oien Oil Corp	3	dsl	500	Natl T-20	280	5,000
Teton County						
Grannell Drlg Co	*1	dsl	400	U-15	450	6,000
Toole County						
Oien Oil Corp	4	dsl	200	Beth S-50	200	3,000
Wibaux County						
Roden & McRae Drlg Corp	3	dsl	900	Emsco GB-800	900	12,500
Tradewinds Drlg Co	3	dsl	—	Emsco GB-800	1275	13,000
	4	dsl	—	Emsco GB-800	1275	13,000
Yellowstone County						
Great Northern Drlg Co	7	dsl	300	Crdwll S	300	6,000
NEBRASKA						
Banner County						
Inland Drlg Co	1	dsl	425	M-CSCO U-34	425	5,500
Kimbark Expl Co	4	dsl	200	M-CSCO U-35A	300	5,500
Lewis Bros Inc	6	dsl	275	Crdwll J-350	225	6,000
Love-Miller Drlg Co Inc	1	dsl	450	Wisn Gnt	520	7,000
Cheyenne County						
Exeter Drlg Co	4	dsl	400	Natl T-32	400	6,600
Garvey Drlg Co	16	dsl	300	Wisn Rdair	450	7,000/3½"
Inland Drlg Co	2	gas	400	Emsco G-36	400	6,000
Greeley County						
Mountain States Drlg Co Inc	17	dsl	540	Natl T-32	—	6,000
Hitchcock County						
Murfin Drlg Co	4	dsl	350	Wisn	400	7,000
Kimball County						
Garvey Drlg Co	18	dsl	300	Wisn Rdair	450	7,000/3½"
Don M Rounds Drlg Co Inc	*2	dsl	900	Crdwll "O"	900	9,000
Sterling Drlg Co	*7	gas	586	M-CSCO U-15	586	7,500
Red Willow County						
Exeter Drlg Co	2	btne	320	Emsco GA-250	250	6,000/4½"
K & E Drlg Inc	*3	dsl	225	Natl T-25	300	5,000
Love-Miller Drlg Co Inc	2	dsl	450	Brwstr N-7	520	8,500
Murfin Drlg Co	2	dsl	300	Natl T-20	300	5,000
	6	dsl	300	Natl T-32	300	6,000
Sterling Drlg Co	*5	gas	586	Emsco GB-350	586	7,000
Earl P Wakefield	1	dsl	440	Wisn Mogul Rdr	440	5,000
Claude Wentworth Drlg Co Inc	*3	gas-dsl	240	Crdwll "S"	175	5,000
Richardson County						
Kirby Oil Ind Inc	—	dsl	300	M-CSCO U-34	275	4,500
NEVADA						
Churchill County						
Barry Well Drlg	*1	gas-dsl	200	Custom Built	150	2,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Avail-able to Drwwks	Rated Depth with 4½" Pipe
Nye County						
Kerr-McGee Oil Ind Inc	7	gas	885	Natl 75	818	11,500
R L Manning Co	6	gas-btne	900	Emsco GB-800	1125	11,000
Terminal Drlg & Prod Co	*5	dsl	490	Ideco H-40-D	400	5,000
	*12	gas	320	Ideco H-30	190	4,000
NEW MEXICO						
Undesignated						
S P Yates Drlg Co	1	dsl	450	M-CSCO U-34	375	5,000
	2	gas	750	M-CSCO U-15	750	9,000
	3	dsl	350	Natl T-12	300	4,000
Chaves County						
Dual Drlg Co	*6	gas	350	Emsco GA-250	400	5,500
Lowe Drlg Co	7	gas	1250	Natl 100	1250	12,500
Moran Oil Prod & Drlg Corp	2	gas	—	Natl 75	750	10,000
Davey O'Brien Drlg Co Inc	4	gas-btne	280	Wisn Spr	145	3,000
Culbertson County						
Great Western Drlg Co	37	gas-gaso	700	M-CSCO U-40	1200	10,000
Eddy County						
Bickerstaff and Tibbetts Drlg Co	*2	gas	—	N-4 Brwstr	320	5,500
	*5	gas	—	Frnks	320	5,000
Brantly Drlg Co Inc	7	gas	975	Beth 450	1125	12,000
FWA Drlg Co Inc	2	—	—	—	—	9,000
Great Western Drlg Co	4	gas	450	M-CSCO U-40	1100	10,000
	25	gas-gaso	275	M-CSCO U-914A	1530	18,000
Lee Drlg Co	2	gas-gaso	1050	"Oilwell" 76	—	13,000
	3	gas-gaso	700	Natl 75	—	10,000
	4	gas-gaso	700	Natl 50	700	8,000
	5	gas-gaso	700	Natl 50	700	8,000
	6	gas-gaso	440	Beth S-55	—	6,000
	7	gas-gaso	700	Natl 50	—	8,000
Rowan Drlg Co Inc	7	gas-btne	1260	Natl 100	1680	14,000
Walters Drlg Co Inc (Dallas)	7	gas	175	Mayhew 1000	175	900/2⅛"
Hockley County						
Great Western Drlg Co	16	gas-gaso	775	M-CSCO U-914A	1260	15,000
Lea County						
Arrow Drlg Co	27	—	450	Emsco 500	532	7,500
Brewster-Bartle Drlg Co Inc	16	gas	—	"Oilwell"	1400	16,000

CUTTING CAPACITIES UP TO 1 INCH 1-1/16 INCH, AND 1-1/2 INCH.

THE Morse-Starrett WIRE ROPE CUTTER

FAST
Especially designed cutting blade and dies of the finest steel assure fast cutting action.

EASY
Anyone can operate it. The hammer principle eliminates any special skill requirements.

SAFE
The enclosed cutting blade locked in the body of the cutter assures perfect safety.

PORTABLE
Models for tool kit or stationary operation. Made in three sizes.

SEE YOUR DEALER OR WRITE TO
MORSE-STARRETT PRODUCTS CO.
1204-49th AVENUE • OAKLAND 1, CALIF.

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Cactus Drlg Corp	8	gas	585	Brwstr N-7	585	9,500
Carper Drlg Co Inc	5	gas	350	Beth S-55	2-365	6,500
	6	gas	350	M-CSCO U-36A	3-365	8,500
	7	gas-btne	450	Natl 55	3-335	9,000
Davidson Drlg Co Inc	*C	btne	660	Emsco GC-500	660	9,000
Delta Drlg Co	9	gas-btne	936	Natl 100	800	12,000
Dual Drlg Co	*4	gas	900	Beth M-810	1050	13,000
Durham Drlg Co Inc	4	gas	1300	Ideco 7-11	1300	16,000
FWA Drlg Co Inc	12	—	—	—	—	7,000
Lloyd R French Co	1	gas-btne	765	Natl 50	600	8,500
Gardner Bros Drlg Co Inc	8	gas-btne	500	Natl 50	675	7,000
	11	gas-btne	750	Natl 100	1050	12,500
Great Western Drlg Co	6	gas	1650	M-CSCO U-914	1650	18,000
	9	gas	1053	M-CSCO U-20	1600	16,000
	12	gas-gaso	1350	M-CSCO U-20	1755	18,000
	21	gas-gaso	840	M-CSCO U-914A	1260	15,000
Helmerich & Payne Inc	32	gas-elec	1100	"Oilwell" 96	1100	14,000
	41	gas	1200	Natl 110	1500	15,000
Hissom Drlg Co	*3	gas-btne	—	Emsco 500	600	8,500
Hondo Drlg Co	5	gas	675	Natl 55	675	11,000
Johnn Drlg Co	6	gas	850	Brwstr N-95	1300	14,000
	8	gas	500	Brwstr N-75	700	10,000
King-Phillips Inc	3	dsl	622	Ideco H-40D	—	5,500/4"
Laughlin-Porter Drlg Co	1	gas	300	Natl T-20	250	4,500
	3	gas	500	Natl 50	500	6,500
Llano Drlg Co	14	gas	300	Brwstr N-45	400	7,000
Lowe Drlg Co	4	gas	750	Natl 75	750	10,000
	6	gas	1000	Natl 100	1000	12,500
	8	gas	1500	Natl 80	1500	15,000
	9	gas	2000	Natl 125	2000	17,000
B L McFarland Inc	12	gas	500	Brwstr N-55	500	7,000
Man Drlg Co	*4	gas	450	Wisn Mogul	450	6,500
Moran Oil Prod & Drlg Corp	3	gas	950	M-CSCO U-15	800	8,500
	4	gas	—	M-CSCO U-34	300	5,000
Parker Drlg Co	33	gas	—	Natl 75	1000	11,000
Schoenfeld-Hunter-Kitch Drlg Co	4	LPG-gas	—	Natl 75	800	11,000
Warton Drlg Co	3	gas	1620	Natl 110	1600	14,000
	4	gas	950	Emsco J-750	1000	12,000
Western Serv Drlg Co Inc	13	gas-btne	550	Beth S-45-E	350	5,000
Rio Arriba County						
Brannon & Murray Drlg Co	1	gas-LPG	550	Brwstr N-55	550	8,500
Colorado & Western Drlg Co	1	dsl	800	Natl 55	800	12,000
Fleeger Drlg Inc	5	—	—	Frnks	—	5,000
	6	—	—	M-CSCO	—	8,500
Great Western Drlg Co	3	gas	680	M-CSCO U-15	680	7,500
	42	dsl	500	Emsco G-500	800	9,000
Nichols Drlg Co	*10	gas	—	—	—	8,000
Rutledge Drlg Co	*4	gas-btne	475	Beth C-50	425	8,000
	*7	gas-btne	356	M-CSCO U-15	555	8,000
Roosevelt County						
Cactus Drlg Corp	7	gas	1000	"Oilwell" 76	1000	12,000
	10	gas	790	Beth M-58	790	10,000
Lloyd R French Co	4	gas-btne	1200	Natl 75	900	12,500
Great Western Drlg Co	34	dsl	495	M-CSCO U-40	1200	10,000
Hissom Drlg Co	*8	gas-btne	—	Emsco A-800	1050	13,000
Johnn Drlg Co	4	gas	375	M-CSCO U-15	600	8,500
Dale Mount Drlg Co	112	gas	1200	EMSCO 750	1200	12,000
	115	gas	1200	Emsco 750	1200	12,000
Rowan Drlg Co Inc	2	gas-btne	840	Natl 75	1120	11,000
San Juan County						
Arapahoe Drlg Co	1	gas-btne	300	Natl T-32	320	6,000
	2	gas-btne	300	Natl T-32	320	6,000
	4	gas-btne	375	Natl 50-A	680	8,000
Brannon & Murray Drlg Co	2	gas-LPG	550	Emsco GA-350	550	6,500
	3	gas-LPG	350	Brwstr N-4	250	5,000
	4	dsl	300	Brwstr N-4	300	5,500
	5	dsl	300	Brwstr N-4	300	5,000
Canadian River Drlg Co	1	dsl	300	M-CSCO U-34	300	5,000
Exeter Drlg Co	2	dsl	800	Natl 50-A	900	8,500
Fleeger Drlg Inc	1	—	—	Beth	—	8,000
	7	—	—	Beth	—	6,500
Foree Drlg Co	2	gas-btne	300	M-CSCO U-15	600	7,500
	3	gas-btne	325	M-CSCO U-15	600	7,500
Gardner Bros	4	2 NKR	—	Natl 50	550	7,500
	18	gas-btne	400	Natl 50	575	7,000
	*19	gas-btne	250	Emsco G-36	350	4,500

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Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
	*21	—	250	Wisn Mogul	250	4,500
Great Western Drlg Co	14	dsl	320	M-CSCO U-15	800	9,000
	20	dsl	265	Frnks SAL-1600	600	5,500
	31	gas-gaso	307	M-CSCO U-15	840	9,000
	32	gas	353	M-CSCO U-15	750	7,500
Hondo Drlg Co	3	gas	675	M-CSCO U-15	675	7,500
Lohmann-Johnson Drlg Co Inc	11	gas	325	Natl 50	600	6,000
Man Drlg Co	*3	gas	650	Wisn Gnt	650	6,500
Moran Bros Inc	3	gas	550	Emsco GB-350-52	550	8,000
	8	gas	1100	"Oilwell" 66	1000	12,000
Rutledge Drlg Co	*2	gas-btne	675	Beth M-58	850	10,000
H F Sears	*14	dsl	300	M-CSCO U-34	300	5,000
Tradewinds Drlg Co	*20	gas-btne	—	M-CSCO U-15	700	8,500
NEW YORK						
Delaware County						
Lohmann-Johnson Drlg Co Inc	6	btne	300	Crdwll "S"	440	4,500
NORTH DAKOTA						
Battineau County						
Calvert Drlg Inc	22	gas-btne	320	Ideco H-35	330	7,000
Billings County						
Penrod Drlg Co	5	dsl	1250	Emsco A-1100	1575	15,000
Burke County						
Calvert Drlg Inc	24	gas-btne	600	M-CSCO U-15	600	8,000
L & J Drlg Ltd	1	dsl	300	Natl 50	300	7,500
Lohmann-Johnson Drlg Co Inc	1	dsl	300	Natl 50	480	5,500
Divide County						
Rutledge Drlg Co	*6	gas-btne	362	Emsco 350	675	8,000
McKenzie County						
Helmerich & Payne Inc	15	dsl	975	"Oilwell" 76	1000	11,000
Gabe McCall Drlg Co	3	gas	1200	Natl N-80	1200	12,000
Penrod Drlg Co	31	dsl	950	Brwstr N-75	830	11,000
Rowan Drlg Co Inc	15	gas-btne	1140	Natl 75	1503	11,000
Rutledge Drlg Co	*1	gas-btne	1100	Beth 810	1257	15,000
	*3	gas-btne	900	Beth 450	850	12,500
Sterling Drlg Co	3	dsl	1100	Emsco GB-800	1100	12,000
Slope County						
Signal Drlg & Expl Inc	5	gas-btne	1400	Natl 80	1200	14,000
Williams County						
Calvert Drlg Inc	25	gas-btne	1050	Beth 810	1100	12,500
Penrod Drlg Co	19	dsl	765	Brwstr N-7	700	10,000
OKLAHOMA						
Undesignated						
Milhoan Drlg Co	1	—	—	Beth MC-450	—	10,000
	1	—	—	Natl 50	—	7,500
	1	—	—	"Oilwell" H-76	—	9,000
Alfalfa County						
Barrett Pet Co	1	gas-gaso	—	Brwstr N-7	450	8,000
Davon Drlg Co	1	gas-LPG	255	Brwstr N-4	320	5,500
Beaver County						
Arrow Drlg Co	10	gas	560	Emsco 500	700	8,500
Barrett Pet Co	2	gas-gaso	—	Natl 50	450	7,500
	5	—	—	Natl 50	—	9,000
D & M Drlg Co Inc	1	gas-btne	550	Natl 50	550	8,000
Foree Drlg Co	4	gas-btne	325	Emsco GA-500	500	7,500
Jack Grace Drlg Co	20	gas-btne	625	Wisn Atlas	1200	11,000
Luke Grace Drlg Co	10	dsl	540	Wisn Gnt	540	8,500
Harper-Turner Drlg Co	1	gas	600	Natl 55	1000	12,000
	2	gas	370	Natl 50	460	7,500
	8	gas	370	Natl 50	510	8,000
Lynn Drlg Co	4	gas-btne	600	Natl 50	600	8,000
	5	gas-btne	725	Natl 75	900	10,500
Midwestern Drillers Inc	2	dsl	320	M-CSCO U-15	600	7,500
	8	dsl	370	M-CSCO U-15	750	8,500
R W Rine Drlg Co	3	gas-btne	520	Brwstr-55	600	7,500
	4	dsl	620	Brwstr N-75	750	9,500
Rowan Drlg Co Inc	10	gas-btne	1020	Beth 450	766	9,000
Tradewinds Drlg Co	*24	gas-btne	—	M-CSCO U-15	700	8,500
	*54	gas-btne	—	M-CSCO U-15	700	8,500
Unit Drlg Co	*2	gas	900	M-CSCO U-15	900	8,500
Wagner & Wyant Drlg Co Inc	1	dsl	300	M-CSCO U-15	675	8,000
Earl F Wakefield	4	gas-btne	750	Wisn Gnt Rdair	750	9,500
Beckham County						
Catline Dodson Drlg Inc	1	gas	450	Beth S-45	220	5,200
Nichols Drlg Co	6	gas	—	—	—	15,000
E L Oliver Drlg Co	5	gas	600	Natl 80	600	6,000/ 8,000
Blaine County						
Big X Drlg Co Inc	2	gas-btne	750	Natl 55	750	10,000
Calvert Drlg Inc	27	—	—	Wisn Spr	—	12,500
Perkins Drlg Co	2	gas-btne	—	M-CSCO U-15	675	8,500
Caddo County						
Graham Drlg Co (Okla)	*1	gas-btne	235	Wisn Mogul	285	5,000
Harper-Turner Drlg Co	9	gas	220	Crdwll	194	4,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Canadian County						
Parker Drlg Co	34	gas	—	Natl 75	1000	10,000
Carter County						
Goff-Looper Drlg Co	4	gas	850	Wisn Gnt	850	12,500
Kingery Drlg Co Inc	3	dsl	210	Wisn	350	4,500
	10	btne-gas	300	Wisn	375	4,500
Kirkpatrick Oil Co	1	gas	300	Beth -60	336	7,500
Nichols Drlg Co	2	gas	—	—	—	14,000
Sherin Drlg Co	1	gas-gaso	500	M-CSCO U-15	600	8,000
	3	gas-gaso	500	M-CSCO U-15	600	8,000
	4	gas-gaso	1000	Natl 100	1050	12,000
	5	gas-gaso	750	Natl 55	750	9,000
Canadian County						
Kirkpatrick Oil Co	4	gas	300	Wisn Gnt	504	8,500
Cleveland County						
Big X Drlg Co Inc	1	gas-btne	750	Beth MC-450	750	10,000
Bryant-Hayward Drlg Co	1	gas	675	Natl 50	675	8,500
Fleeger Drlg Co	2	—	—	Wisn Rdair	—	8,500
Nichols Drlg Co	*5	gas	—	—	—	14,000
E L Oliver Drlg Co	6	gas	600	U-15	600	6,000/ 8,500
O'Neal-Garvin Drlg Co	4	gas	650	Emsco GA-500	650	10,000
Chester H Westfall Drlg Co	2	gas-gaso	625	M-CSCO U-15	700	10,400
Coal County						
Holliman Drlg Co	1	gas	500	M-CSCO U-15	900	8,500
Tradewinds Drlg Co	*46	gas-btne	—	Beth S-60	575	8,000
Creek County						
Mike Marre	*5	gas	225	Wisn	200	4,000
Masker Drlg Co	1	gas	214	Joy 300	170	2,500
Shaw-Hughes Drlg Co	2	btne-gas	270	Natl T-20	250	4,500
Custer County						
Parker Drlg Co	61	gas-elec	2500	Natl 23x10½	1500	20,000
Dewey County						
Helmerich & Payne Inc	24	gas	950	Natl 80	1100	11,000
Nichols Drlg Co	9	gas	—	—	—	10,000
Tradewinds Drlg Co	*10	gas-btne	—	M-CSCO U-15	700	8,500
	*58	gas-btne	—	Beth MC-450	700	10,000
Ellis County						
Big Chief Drlg Co	33	gas	1250	Natl 55	1250	11,000
Helmerich & Payne Inc	36	gas	500	Emsco GB-500-S2	700	9,000
	38	gas	950	Natl 80	1100	11,000
O'Neal-Garvin Drlg Co	3	gas	650	Natl 50	650	9,500
Tommy Ward Drlg Co	*2	gas	—	Brwstr N-45	—	—
Garfield County						
Hayward Drlg Co	1	gas	200	Carson	125	3,500
Reed Drlg Co Inc	2	gas-gaso	—	Crdwll D	410	5,500
Garvin County						
Barrett Pet Co	3	dsl	—	Wisn gnt	300	5,500
Crown Drlg Co	*2	gas	750	M-CSCO U-15	750	8,500
Lynn Drlg Co	3	gas-btne	1500	Natl 100	1500	17,000
Nichols Drlg Co	*8	gas	—	—	—	9,000
Parker Drlg Co	37	gas	—	Natl 100	1400	14,000
Perkins Drlg Co	3	gas-btne	400	Beth S-60	370	7,500
Grady County						
Big Chief Drlg Co	30	gas	1545	Ideco 1050	1515	15,000
T T Eason & Co Div of Eason Oil Co	12	gas-btne	1000	Natl 80-B	1060	12,500
Helmerich & Payne Inc	44	gas	1200	"Oilwell" 96	1500	15,000
Nuckolls-Bell Drlg Co	4	gas	1100	Natl 80-B	1200	13,000
Parker Drlg Co	41	gas	—	Natl 100	1400	14,000
Dick Wegener Drlg Co	*4	gas-dsl	1900	Natl 130	1900	22,000
Grant County						
Lohmann-Johnson Drlg Co Inc	8	dsl	300	Natl 32	550	7,500
Harper County						
Davon Drlg Co	2	gas-LPG	350	Brwstr N-4	320	5,500
Hughes County						
Jonco Drlg Co	*2	gas-gaso	300	Beth S-45-A	200	5,000
Reed Drlg Co Inc	3	gas-gaso	180	M-CSCO U-34	180	3,200
Troup & Suttles Inc	2	gas-gaso	200	Wisn	370	6,500
	3	gas-gaso	Drilling in Units			
Jefferson County						
Parker Drlg Co	32	gas	—	Natl 50	1000	9,000
Kay County						
Dave Morgan Drlg Co	—	LPG-gas	350	Natl T-37	320	6,000
Kingfisher County						
Arrow Drlg Co	20	gas	460	Emsco 350	600	7,500
Big Chief Drlg Co	1	gas	450	JS&G Spad "Spr"	450	6,500
	27	gas	760	JS&G Spad Spr	760	9,000
Bodard Drlg Co	5	gas	450	M-CSCO U-34	185	7,000
Bryant-Hayward Drlg Co	2	gas	675	Natl 50	675	8,500
	4	gas	900	Brwstr N-75	900	12,000
Calvert Drlg Inc	18	gas-btne	—	M-CSCO U-15	585	8,500
	19	dsl	350	M-CSCO U-15	600	8,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Christian, Sarratt & Wallace Ltd	83	—	—	Frnks 658	—	
D & M Drlg Co Inc	2	gas-btne	900	M-CSCO U-15	900	9,000
Davon Drlg Co	*3	gas-LPG	675	Brwstr N-7	675	8,500
	5	gas-LPG	350	Brwstr N-45	425	7,300
N V Duncan Drlg Co	4	gas	600	Beth 450	600	9,000
T T Eason & Co Div of Eason Oil Co	14	gas-btne	750	Emsco GB-500	940	10,000
	15	gas-btne	750	Emsco GA-250T	450	6,900
Garr-Woolley Co	2	dsl	700	Emsco 350	800	8,000
Hap Drlg Co	*1	gas	1600	Wlsn Spr Atlas	1200	12,000
Harper-Turner Drlg Co	4	gas	370	Natl 50	460	7,500
Holliman Drlg Co	2	gas	350	M-CSCO U-15	550	7,500
Nuckolls-Bell Drlg Co	3	dsl	700	Ideco H-525	704	9,500
Parker Drlg Co	56	gas	—	Natl 50	1000	9,000
Patco Drlg Contr Inc	2	dsl	350	M-CSCO U-15	600	8,000
R W Rine Drlg Co	6	dsl	520	Brwstr N-75	750	12,000
Sabre Drlg Co	3	dsl	285	M-CSCO U-36	560	7,500/4½"
Sherin Drlg Co	2	gas-gaso	800	M-CSCO U-15	800	9,000
Stickle Drlg Co	*5	dsl	300	T-32 Ideal	300	6,500
	*6	dsl	300	Brwstr N-45	300	7,000
Latimer County						
Big Chief Drlg Co	5	gas	1545	Emsco 1250	1545	15,000
Le Flore County						
Big Chief Drlg Co	36	gas	800	Natl 55	800	11,000
Lincoln County						
Dudley & Heath Drlg Co	7	dsl	265	Brwstr N-4	320	5,500
Garr-Woolley Co	1	gas-btne	278	Emsco 300	378	6,500
Sabre Drlg Co	1	gas	290	T-20	240	5,500
Logan County						
Davon Drlg Co	4	gas-LPG	320	Brwstr N-2	320	3,500/2⅛"
Love County						
Goff-Leeper Drlg Co	5	gas	850	Ideco H 7-11	850	13,000
Nichols Drlg Co	77	gas	—	Wlsn	—	18,000
McClain County						
Crown Drlg Co	*1	gas	720	M-CSCO U-15	720	8,500
Flournoy-Haston Drlg Co Inc	3	gas	600	Wlsn Spec	800	10,000
	4	gas	700	Natl 100	1000	12,000
Garvey Drlg Co	21	dsl	500	M-CSCO U-15	640	8,500
Goff-Leeper Drlg Co	1	gas	800	Brwstr N-75	800	12,000
	3	gas	450	M-CSCO U-15	450	8,000
Perkins Drlg Co	4	gas-btne	1200	Beth 650	1200	12,000
Tradewinds Drlg Co	*66	gas-btne	—	Wlsn Spr Titan	1050	13,000
	*68	gas-btne	—	Beth MC-450	700	10,000
Chester H Westfall Drlg Co	1	gas-gaso	700	M-CSCO U-15	800	10,400
	3	gas-gaso	625	M-CSCO U-15	700	10,400
McIntosh County						
Reed Drlg Co Inc	4	gas-gaso	300	M-CSCO U-34	290	5,000
Major County						
Helmerich & Payne Inc	26	gas	500	Emsco GB-500	700	9,000
N V Duncan Drlg Co	2	gas	600	Emsco 750	600	9,000
Sterling Drlg Co	*2	gas-btne	675	Unit rig U-15	675	7,500
Noble County						
Barrett Pet Co	4	dsl	—	M-CSCO U-10	350	6,500
Bryant-Hayward Drlg Co	5	dsl	350	Frnks 5000	400	5,000
Indian Drlg Co	2	dsl	220	Ideco H-35-S	350	5,000
Kirk Drlg Co	*1	gas	200	T-12	200	2,500
	*1	dsl	225	N-3	225	4,000
	*1	dsl	265	T-20	265	6,000
	*1	dsl	265	U-34	265	5,500
Okfuskee County						
Johnson-Bates Drlg Co	1	gas	245	M-CSCO U-34	300	5,000
	2	gas	325	M-CSCO U-34	245	6,500
Seran & Howard Drlg Co	1	gas	225	Beth	200	5,000
Shaw-Hughes Drlg Co	3	btne-gas	270	Natl T-20	250	5,000
Unit Drlg Co	*1	gas	290	M-CSCO U-34	226	5,500
Wade Drlg Co Inc	1	dsl	225	Crdwll L	185	3,500
Oklahoma County						
Catline Dodson Drlg Inc	2	gas	675	M-CSCO U-15	675	9,000
Harper-Turner Drlg Co	5	gas	220	Emsco G-300	340	6,000
Patco Drlg Contr Inc	*1	dsl	325	M-CSCO U-34	300	5,300
Smiley Drlg Co	*4	gas	100	"Oilwell"	152	2,600
Osage County						
Gross Drlg Co	1	dsl	—	M-CSCO	250	5,000
	5	prop-btne	—	Beth S-45	250	5,000
Indian Drlg Co	1	btne	220	Ideco H-25	250	4,000
Mosker Drlg Co	2	gas	185	Joy 300	160	2,500
Pawnee County						
Dudley & Heath Drlg Co	6	dsl	265	Crdwll S	320	5,500
Wade Drlg Co Inc	3	dsl	325	Crdwll L	225	4,500
Payne County						
Sabre Drlg Co	4	gas-LPG	225	Brwstr N-3	180	3,500/4"
Pittsburg County						
Goff-Leeper Drlg Co	2	gas	225	Brwstr N-4	350	6,000
Pontotoc County						
RWIT Drlg Co	2	gas-gaso	150	Mayhew 1000	150	1,500
	2	gas	—	Mayhew 1000	190	1,000
Pottawatomie County						
Bodard Drlg Co	*1	gas	225	M-CSCO U-34	185	4,500
Flournoy-Haston Drlg Co Inc	2	gas	300	M-CSCO U-15	650	8,000
Reed Drlg Co Inc	1	dsl	420	M-CSCO U-34	235	6,000
Pontotoc County						
Don Clawson	1	gas-btne	340	Brwstr N-4	185	4,500
Melco Drlg Co	2	btne	265	Brwstr N-35	185	5,000
Seminole County						
M Houston Drlg Co	*2	gas	225	Unit U-34	185	5,500
Jonco Drlg Co	*1	gas-gaso	300	Emsco 160	200	5,000
Art Logan Drlg Co	1	dsl	500	Ideco 525	500	6,000
Melco Drlg Co	1	btne	265	Brwstr N-35	185	5,000
RWIT Drlg Co	1	gas	—	Brwstr N-3	145	3,500
	*1	gas	185	Brwstr N-3	150	3,600
Troup & Suttles Inc	1	gas	750	Wlsn Gnt	225	6,000
Stephens County						
Big Chief Drlg Co	35	gas	2610	Natl 110	2610	16,000
Bryant-Hayward Drlg Co	6	gas	700	Brwstr N-7	7000	9,000
Flournoy-Haston Drlg Co Inc	5	gas	700	Natl 100	1000	12,000
Helmerich & Payne Inc	47	gas-btne	2000	"Oilwell" 96-16	2000	20,000
Holliman Drlg Co	4	gas	325	M-CSCO U-15	500	7,500
	6	gas	750	Wlsn Atlas	950	11,000
Nichols Drlg Co	*1	gas	—	Wlsn	—	7,000
	4	Wlsn	7000	—	—	7,000
	11	gas	—	—	8000	8,000
Parker Drlg Co	30	gas	—	Natl 50	1000	9,000
Pierco Drlg Co	1	gas-LPG	400	Wlsn Mogul	165	4,200
Texas County						
Garvey Drlg Co	20	dsl	300	Wlsn Mogul 42	450	7,000
Graham-Michaelis Drlg Co	10	dsl	600	M-CSCO U-15	600	9,000
Midwestern Drillers Inc	7	dsl	370	M-CSCO U-15	750	8,500
Moran Bros Inc	16	gas	650	M-CSCO U-15	600	7,500
Earl F Wakefield	6	dsl	960	Wlsn Atlas Rdair	960	13,000
Tommy Ward Drlg Co	*3	gas	—	Brwstr	—	—
Tillman County						
E W Moran Drlg Co	5	gas	370	Natl 50	650	7,500
Tulsa County						
Herring Drlg Co	*1	gas	150	Mayhew 2500	180	2,500
	*2	gas	125	Mayhew 2000	125	1,500
Washita County						
Parker Drlg Co	55	gas-elec	—	Emsco 750	1000	10,000
	57	gas	—	Natl FE-34-10	1800	18,000
	60	gas-elec	—	Natl 130	2000	25,000
Woods County						
Lynn Drlg Co	1	gas-btne	300	Natl 50	600	8,000
Woodward County						
Helmerich & Payne Inc	46	gas	500	Emsco GB-500-52	700	9,000
Tommy Ward Drlg Co	*1	gas	—	M-CSCO U-15	—	—
PENNSYLVANIA						
Bedford County						
Delta Drlg Co	10	dsl	370	M-CSCO U-15	500	8,500
Blair County						
Fairman Drlg Co	1	gas-btne	500	Beth M-58	600	10,000
Clearfield County						
Delta Drlg Co	24	dsl	620	Emsco GC-500	800	10,000
	34	gas-btne	370	M-CSCO U-15	700	8,500
Fairman Drlg Co	2	gas-btne	500	"Oilwell" 66	600	9,000
S W Jack Drlg Co	3	gas	650	M-CSCO U-15	650	8,500
Indiana County						
S W Jack Drlg Co	2	dsl	800	M-CSCO U-15	800	8,500
Potter County						
Fairman Drlg Co	3	gas-btne	500	Wlsn Gnt	600	9,000
Delta Drlg Co	27	dsl	370	Emsco GA-350	500	7,000
Warren County						
Washington County						
Delta Drlg Co	33	gas-btne	370	Natl 50-A	700	8,500
Lohmann-Johnson Oil Co Inc	9	gas	750	"Oilwell" 66	500	10,000
Westmoreland County						
Delta Drlg Co	30	gas-btne	670	Emsco G-500	700	10,000
Lohmann-Johnson Oil Co Inc	2	gas	750	"Oilwell" 76	500	10,000
York County						
S W Jack Drlg Co	1	gas	635	M-CSCO U-15	635	8,500
TEXAS						
Undesignated						
Howgley Drlg Co	3	dsl	—	Emsco J-750	975	10,000
Norwood Drlg Co	6	gas-gaso	650	Wlsn Titan	900	12,000
A L & J N Varner	2	btne	—	Failing HD-1500	100	1,500
Anderson County						
Robert M Bass Drlg Contr	5	gas-LPG	300	Wlsn Gnt	300	5,500
	4	gas-LPG	350	Brwstr N-35	350	7,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
B G Byars Power Drlg Co	2	gas-btne	1145	Emsco GA-500	750	10,500
Discovery Drlg Inc	11	dsl	1200	Wisn Titan	900	14,000
Gulley, Long & Hedge Drlg Co Inc	*2	dsl	—	Wisn Mogul	—	6,000
Maxwell Herring Drlg Corp	1	gas	—	Wisn Mogul	—	6,000
Andrews County						
B B M Drlg Co	5	gas-btne	1100	Emsco J-750	800	12,800
Brantly Drlg Co Inc	8	gas	675	Beth 450	870	11,000
Cactus Drlg Co	2	gas	395	Brwstr N-4	496	6,000
	11	gas	395	Brwstr N-4	496	6,000
Dual Drlg Co	*5	gas	700	Emsco 500	700	8,500
Durham Drlg Co Inc	3	gas	1250	M-CSCO U-20	1250	14,000
FWA Drlg Co Inc	11	—	—	—	—	9,000
Gardner Bros Drlg Co Inc	10	gas-btne	750	Natl 100	1050	12,500
	14	gas-btne	750	Natl 100	1050	12,500
Great Western Drlg Co	17	gas-gaso	765	M-CSCO U-914B	1260	15,000
	35	dsl	300	M-CSCO U-15	760	7,500
	38	dsl	320	M-CSCO U-15	550	6,500
King-Phillips Inc	1	gas-gaso	695	Natl 50	—	7,500
	4	gas	700	Beth S-45E	350	6,500
Lowe Drlg Co	5	gas	750	Natl 75	750	10,000
	10	gas	1800	Natl 125	1800	17,500
B L McFarland Inc	*7	gas	285	M-CSCO	290	4,000
Davey O'Brien Drlg Co Inc	2	gas-btne	840	Emsco GA-500	840	9,000
Fred Pool Drlg Co	3	—	—	U-10	—	5,500
Rowan Drlg Co Inc	9	gas-btne	900	Natl 75	1110	11,000
Aransas County						
Camden Drlg Co	*Bge 2	dsl	600	Natl T-32	300	7,500
Archer County						
R W Darden Drlg Co	1	gas	145	Wichtex R-3	140	3,000
Jack Grace Drlg Co	19	gas-btne	255	Wisn Gnt	350	5,000
Man Drlg Co	*5	gas	350	Wisn Gnt	225	5,500
Baylor County						
Horizon Oil Inc	*1	dsl	400	Wisn Mgl Trcr	200	5,000
A D McDuffie Contr	*1	btne	170	Big Four	145	2,500
Bee County						
Gilmour Drlg Co	*1	dsl or gas	350	M-CSCO U-15	600	8,500
Penrod Drlg Co	4	dsl	1500	Natl 130	1500	20,000
Rhodes & Hicks Drlg Corp	1	gas-btne	370	Frnks 137	200	5,500
Viking Drlg Co	3	gas-gaso	800	M-CSCO U-15	660	9,000
Borden County						
Forest Blackstock Inc	4	gas	700	Emsco GB-350	700	8,000
Hewgley Drlg Co	4	gas-btne	—	Emsco GA-500	650	8,500
Rheay & Reynolds Drlg Co	5	gas	350	Natl 75	1200	8,000
Warton Drlg Co	2	gas	600	Natl 50	700	8,500
Brazoria County						
Clegg & Hunt	7	dsl	—	Natl 75	880	11,000
C J Foster Drlg Co Inc	4	gas	1120	Crdwll "O"	750	11,500
Dillard-Waltermire Inc	4	stm	1200	Natl 34-10-FE	1500	16,000
Hunt Drlg Co Inc	7	stm	1200	Emsco ECA	1200	16,000
Penrod Drlg Co	20	dsl	1400	Natl 80-B	1400	13,000
Southland Drlg Co	*4	dsl	850	Brwstr N-7	900	10,000
C B Webster Drlg Co	2	gas	900	Emsco GB-500	850	—
Brooks County						
Stewart & Gouger Drlg Co	3	gas-btne	600	Emsco GB-500	700	9,500
Brewster County						
Hissom Drlg Co	*1	gas-btne	—	Emsco 500	675	10,000
Caldwell County						
R V Muckelroy & Son	1	LPG	75	Wisn	75	2,500
	1	dsl	225	Bethlehem	225	4,500
Calhoun County						
E L Bass Drlg Co	*1	rotary	—	M-CSCO U-15	—	10,000
	*2	rotary	—	M-CSCO U-15	—	10,500
Layton Brown Drlg Co	*2	dsl	810	Brwstr N-7	600	11,000
	3	stm	—	—	—	10,000
Columbia Drlg Co	6	dsl	1060	Emsco GA-500	660	11,000
Mangum Drlg Co	3	gas	1175	M-CSCO	675	9,000
Penrod Drlg Co	Bge 42	dsl	2000	Brwstr N-12-A	1150	18,000
Texdrill Corp	*2	gas-LPG-dsl	988	M-CSCO U-15	560	10,000
Callahan County						
Low Drlg Co	2	btne	—	Wisn	145	3,000
Cameron County						
Brewster-Bartle Drlg Co Inc	17	dsl	—	"Oilwell" 96	1500	16,000
Fitzpatrick Drlg Co	4	gas	1050	Beth Tornado	1000	13,000
Parker Drlg Co	52	gas	—	"Oilwell" 76	1400	12,500
Carson County						
FWA Drlg Co Inc	14	—	—	—	—	4,500
	18	—	—	—	—	4,500
Luke Grace Drlg Co	18	dsl	540	M-CSCO U-15	540	9,000
Cass County						
Butler-Johnson Inc	3	gas-btne	400	Brwstr N-45	400	7,500
Big Chief Drlg Co	38	gas	900	Natl 75	900	13,000
B G Byars Power Drlg Co	4	gas-btne	1110	Emsco J-750	1110	14,000
M J Delaney Co	27	gas-btne	500	Beth 450	850	11,000
	32	gas-btne	500	Beth 450	750	11,000
Chambers County						
Big "6" Drlg Co	5	gas-btne	820	Wisn Gnt	550	10,500
Columbia Drlg Co	*1	dsl	800	"Oilwell" 76	750	12,000
Grey Wolf Drlg Co	1	gas-btne	1170	Emsco GB-880	1050	12,500
Rowan Drlg Co Inc	Bge 20	dsl	1120	Natl 75	1300	12,000
Clay County						
Jack Grace Drlg Co	17	gas-btne	370	Wisn Gnt	700	8,000
Wes-Mor Drlg Inc	*1	gas-btne	450	Wisn Gnt	4500	6,800
Coke County						
Roy Guffey Drlg Co	3	gas-btne	440	M-CSCO U-34	235	5,500
Herb Expl Co	3	btne	—	Failing 1500	—	1,500/2½"
Rheay & Reynolds Drlg Co	3	gas	400	M-CSCO U-15	1200	6,500
Wes-Tex Drlg Co	5	btne	550	Natl 50	550	7,500
Coleman County						
Burger Drlg Co	*1	gas	225	Wisn Mogul	—	4,000
Graytex Drlg Co	2	gas	325	Natl T-12	325	4,500
Raiborn Drlg Co	2	gas	200	Crdwll RL	185	5,000
Rhodes Drlg Co	11	gas	240	Emsco 350	360	5,000
Colorado County						
Southland Drlg Co	*6	dsl	1000	Natl 55	1000	11,500
Cooke County						
Alan Drlg Co	*3	gas	300	Wisn Mogul	185	3,500
Berry Drlg Co	1	dsl	350	Wisn Gnt	500	6,500
Felderhoff Bros Drlg Co	1	gas	285	Wisn Mogul	185	4,600
Roy Guffey Drlg Co	5	gas-btne	440	M-CSCO U-34	235	5,500
Russell & Russell Drlg & Prod Co	*1	—	300	Wisn Torcair	450	5,000
T & O Drlg Co	2	dsl	200	Wisn Super	130	3,000
	3	gas	240	Wisn Mogul	145	4,500
Trachta Drlg Co	1	dsl	250	Wisn	185	3,000
Crane County						
Cactus Drlg Corp	6	gas	1200	Ideco 7-11	1200	12,000
Dillard-Waltermire Inc	14	gas	600	Wisn Gnt	800	8,000
FWA Drlg Co Inc	10	—	—	—	—	5,000

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RECTORSEAL #5
THE POSITIVE LEAK PREVENTER

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Gardner Bros Drlg Co Inc	6	gas-btne	500	Natl 75	1100	12,500
	12	gas-btne	750	Natl 100	1050	12,500
	16	gas-btne	1000	Natl 125	1400	15,000
Guadalupe Drlg Co	1	gas-btne	700	Ideco M 1000	—	10,000
O E Hall Drlg Co	1	gas	320	M-CSCO U-15	700	8,000
Helmerich & Payne Inc	9	gas	1200	"Oilwell" 96	1100	14,000
	42	gas	970	Natl 100	1000	13,000
	43	gas	900	"Oilwell" 76	1100	11,000
Johnn Drlg Co	5	gas	375	M-CSCO U-15	600	8,500
	7	gas	325	Brwstr N-45	400	7,000
	9	gas	375	Brwstr N-45	400	7,000
Llano Drlg Co	9	dsl	300	Brwstr N-4	300	5,500
Gene McCutchin Drlg Co	*5	gas	275	Wisn Gnt	275	5,500
	#10	gas	550	Natl 50	550	8,000
McDaniel & Beecherl Drlg Co	10	gas-gaso	—	"Oilwell" 66	—	7500 to 10,000
Dale Mount Drlg Co	101	gas	850	Emsco 500	570	9,000
	111	gas	1200	Emsco 1250	1200	14,000
Parker Drlg Co	53	gas	—	Natl 75	1000	11,000
Ray Smith Drlg Co Nancy Ann II		gas-LPG	225	Ideco H-25	160	4,500/3½"
Tri-Service Drlg Co	6	gas	1350	"Oilwell" 96	1350	16,000
Crockett County						
Brantly Drlg Co Inc	3	gas	700	Brwstr N-75	750	11,000
Delta Drlg Co	4	gas-btne	800	Natl 100	800	12,000
Dual Drlg Co	*2	gas	600	Wisn Gnt	700	8,500
John Grappe Drlg Co	*2	gas	1700	Beth M-58	700	12,000
	*3	gas	1700	Beth M-58	850	12,000
Great Western Drlg Co	27	gas-gaso	853	M-CSCO U-914A	1340	18,000
Llano Drlg Co	10	gas	550	Brwstr N-55	500	9,000
Norwood Drlg Co	7	gas-gaso	650	Wisn	700	9,500
	8	gas-gaso	350	Wisn	175	4,000
Raiborn Drlg Co	1	gas	200	Wichtex R-6	185	5,000
Schoenfeld-Hunter-Kitch Drlg	9	LPG-gas	—	Natl 75	900	11,000
Crosby County						
B L McFarland Inc	6	gas	1050	Brwstr N-95	1050	14,000
Culberson County						
Rowan Drlg Co Inc	22	gas-btne	600	Natl 50	766	7,000
Dallam County						
Luke Grace Drlg Co	4	dsl	270	Wisn Gnt	270	5,500
Dawson County						
Cactus Drlg Corp	4	gas	1185	"Oilwell" 76	1185	12,000
Lee Drlg Co	1	gas-gaso	1050	Natl 100	700	13,000
Llano Drlg Co	4	gas	820	Natl 75	1050	12,000
Dale Mount Drlg Co	114	gas	300	Crdwll	300	5,000
Parker Drlg Co	4	gas	—	Natl 100	1400	14,000
Delta County						
Robert M Bass Drlg Contr	3	gas-LPG	400	Wisn Gnt Rdair	600	8,500
Gibson Drlg Co	*3	gas	375	Wisn Mogul 42	530	6,500
De Witt County						
Allen & Morris Drlg Co	7	dsl	1240	Natl 75	1200	12,000
Chiles Drlg Co	4	gas	1000	Brwstr N-7	600	10,500
Harkins & Co	1	gas-gaso	555	M-CSCO U-15	555	9,500
	7	dsl	600	M-CSCO U-15	600	9,500
	8	gas-btne	1625	N-100	1810	14,500
Horn Drlg Co	1	dsl	450	Brwstr N-45	—	7,000
Mangum Drlg Co	2	stm	1400	Emsco	1400	12,000
Penrod Drlg Co	3	dsl	2200	Brwstr N-95	1400	13,500
	32	dsl	1300	Brwstr N-12	2100	18,000
Stewart & Gouger Drlg Co	4	gas-btne	1000	Natl 110	1100	16,000
Yarborough Drlg Co	1	dsl	520	Wisn Gnt	520	9,000
Dimmit County						
General Well Drlg Inc	3	gas-btne	425	Beth	183	5,500/3½"
	8	btne	400	Brwstr N-4	185	4,500/3½"
Longhorn Drlg Corp	*4	gas-btne	500	M-CSCO U-15	675	9,500
Duval County						
Allen & Shumate Inc	5	gas	300	Ideco H-30	280	4,500
Davis & Bates Inc	1	dsl	549	Brwstr N-4	460	7,500
Falco Drlg Co	1	gas	750	Brwstr N-45	450	7,500
Prince Marine Drlg & Exp Co	9	btne-dsl	500	Natl T-32	450	7,000
Southland Drlg Co	*2	gas	800	Brwstr N-55	750	9,500
Ector County						
Coroco Drlg Co	2	gas-gaso	650	"Oilwell" 96	900	15,000
	4	gas-gaso	650	Wisn Spr Titan	900	15,000
Davidson Drlg Co Inc	*D	btne	315	Wisn Mogul	600	7,500
Dillard-Waltermire Inc	12	gas	600	Wisn Gnt	800	8,000
	13	gas	800	Wisn Titan	1200	12,000
	16	gas	500	Natl 50	700	6,500
Durham Drlg Co Inc	2	gas	648	M-CSCO U-15	648	8,500
FWA Drlg Co Inc	4	—	—	—	—	7,000
	7	—	—	—	—	12,000
Empire Drlg Co	*5	gas	350	M-CSCO U-15	500	8,500
Lloyd R French Co	2	gas-btne	675	M-CSCO U-15	600	8,500
	3	gas-btne	650	Natl 50	600	8,500
Parker Drlg Co	16	gas	—	Natl 100	1400	14,000
Schoenfeld-Hunter-Kitch Drlg Co	1	LPG-gas	—	Beth 650	1000	14,000
	6	LPG-gas	—	Beth 650	1000	14,000
	7	LPG-gas	—	Natl 110	1200	16,000
	10	LPG-gas	300	Beth Twstr	300	6,500
Ray Smith Drlg Co Sophie Jean		gas-LPG	625	Natl 50	625	8,000
Thompson Expl Drlg Co	8	gaso	100	Failing 1500	100	1,500
Tri-Service Drlg Co	2	gas	675	"Oilwell" 66	675	8,500
Western Serv Drlg Co Inc	1	gas-btne	340	Natl 50	360	5,000
	2	gas-btne	600	Natl 50-A	700	8,000
	7	gas-btne	600	Natl 50	700	7,000
	8	gas-btne	600	Beth MC-650	700	11,000
	11	gas-btne	1000	Beth 810	1100	11,000
Edwards County						
Thomas & Billups Drlg Co	7	btne	820	Wisn Gnt	820	9,000
Fisher County						
Dixon Drlg Co	5	gas	400	M-CSCO U-15	600	7,000
Thomas & Billups Drlg Co	2	btne	450	Emsco 300	450	6,000
West Central Drlg Co	12	gaso-btne	675	Wisn Rdair	675	10,000
Foard County						
E W Moran Drlg Co	7	gas	225	Crdwll L	225	4,500
Ft Bend County						
C J Foster Drlg Co	*9	gas	800	Houston Port CT-5	500	8,500
Franklin County						
M J Delaney Co	28	gas-btne	500	"Oilwell" 96	1000	14,000
Parker Drlg Co	44	gas	—	Natl 125	1400	15,000
Freestone County						
Gibson Drlg Co	*2	gas	275	Wisn Mogul 42	265	5,000
Frio County						
Dixon Drlg Co	1	dsl-gas	260	Natl T-20	260	5,000
Schimmel Drlg Co	1	dsl	350	Wisn Gnt	600	8,000
Gaines County						
B B M Drlg Co	1	gas-btne	950	Emsco GB-800	1050	14,000/4"
Cactus Drlg Corp	1	gas	1800	Natl 110	1800	16,000
	5	gas	790	Natl 75	790	10,000
	12	gas	665	"Oilwell" 76	665	9,000
Delta Drlg Co	2	gas-btne	400	Natl 50	450	7,000
FWA Drlg Co Inc	9	—	—	—	—	5,000
O E Hall Drlg Co	3	gas	600	M-CSCO U-15	700	8,000
Hewgley Drlg Co	1	gas-btne	—	Emsco GA-500	650	8,500
	6	gas-btne	—	Emsco GB-500	650	9,000
Parker Drlg Co	51	gas	—	Natl 50	1000	9,000
Fred Pool Drlg Co	1	gas	580	M-CSCO U-15	600	7,500
Rowan Drlg Co Inc	12	gas-btne	1260	Natl 100	1680	14,000
	16	gas-btne	504	Natl 50	660	7,000
Galveston County						
Drlg & Expl Co Inc	—	dsl	1250	Natl 80-B	1500	14,000
C J Foster Drlg Co Inc	1	stm	1800	Emsco ECB	1400	15,000
Grey Wolf Drlg Co	4	gas-btne	780	Emsco GB-500	890	9,500
Kilroy Drlg & Prod Co	3	gas	1000	Brwstr 75	1000	12,000
Garza County						
B B M Drlg Co	10	gas-btne	750	Emsco GA-500	700	7,000/3½"
Davey O'Brien Drlg Co Inc	5	gas-btne	560	Wisn Gnt	560	8,000
Rheay & Reynolds Drlg Co	4	gas	350	Natl 50	1200	7,000
Glasscock County						
B B M Drlg Co	4	gas-btne	550	Natl 50	600	8,500/3½"
O E Hall Drlg Co	5	gas	700	M-CSCO U-40	1210	12,000
Red River Drlg & Prod Co	*2	gas	185	Wich R-4	145	3,000
Goliad County						
Chiles Drlg Co	1	gas	648	Emsco 500	730	9,500
Dan L Clark Drlg Co Inc	2	gas-btne	1000	Emsco GC-500	500	7,500
Gonzales County						
Penrod Drlg Co	21	dsl	1850	Brwstr N-85	1200	—
Sutton Drlg Co Inc	7	dsl	—	Ammco	225	5,090
Viking Drlg Co	5	gas	520	M-CSCO U-10	480	7,500
Gray County						
Holt Bros Drlg Co	*2	dsl	270	Ideco H-20	270	4,000
Murphy & McKernan	1	dsl	390	M-CSCO U-15	375	7,500
Grayson County						
FWA Drlg Co Inc	6	—	—	—	—	4,500
H O Grace Drlg Co	3	btne	—	—	—	6,000
Jack Grace Drlg Co	12	gas-btne	625	Wisn Atlas	1200	10,000
The Grande Corp	3	gas	—	Emsco	696	15,000
	5	gas	—	M-CSCO U-15	—	9,500
	9	gas	1600	Emsco A-1500	2500	25,000
E W Moran Drlg Co	4	gas	500	Wisn Gnt	650	7,500
Gregg County						
Gibson Drlg Co	*4	gas	275	Wisn Mogul 42	265	5,000
Gulley, Long & Hedge Drlg Co Inc	4	gas-btne	—	Wisn Gnt	—	8,000
Maxwell Herring Drlg Corp	8	gas	—	Wisn Mogul	—	5,000
Hale County						
Forest Blackstock Inc	1	gas	700	Emsco GB-350	700	8,000
Great Western Drlg Co	40	gas	450	Wisn Atlas	840	10,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Avail-able to Drwwks	Rated Depth with 4½" Pipe
Hansford County						
Arrow Drlg Co	28	gas	840	Natl 50	532	8,000
Dillard-Waltermire Inc	1	gas	600	Wlsn Gnt	—	8,000
	15	gas	800	Wlsn Atlas	1200	11,000
Foree Drlg Co	5	btne	350	"Oilwell" 52-T	426	6,000
Garvey Drlg Co	6	dsl	276	M-CSCO U-15	640	8,500
Luke Grace Drlg Co	7	dsl	750	Wlsn Air Atlas	750	12,500
Helmerich & Payne Inc	7	gas	500	Emsco GB-500-82	700	9,000
J S Montgomery	3	gas	1100	Natl 80	1100	12,000
Moran Bros Inc	2	gas	700	Emsco GA-500	750	9,500
Wagner & Wyant Drlg Co Inc	2	dsl	500	M-CSCO U-15	675	9,000
Hardeman County						
Jack Grace Drlg Co	8	gas-btne	600	Wlsn Gnt	700	8,000
E W Moran Drlg Co	2	gas	500	Wlsn Gnt	650	7,500
	3	dsl	500	Wlsn Gnt	650	7,500
Hardin County						
Mac Drlg Co	*5	gas-gaso-btne	275	Beth S-45	450	7,500
Miller Bros & Bowling	2	gas-btne	800	Emsco G-450	—	8,500
Harris County						
Brewster-Bartle Drlg Co Inc	9	dsl	—	"Oilwell" 96	1500	16,000
Grey Wolf Drlg Co	3	dsl-elec	1534	Emsco ECB	1250	20,000
WLB Drlg Co	*2	gas-gaso-btne	390	M-CSCO U-34	226	4,500
Haskell County						
Dugger & Herring Drlg Co	2	dsl	—	Gdnr Den U-15	—	10,000
E W Moran Drlg Co	6	gas	225	Wlsn Mogul	160	4,500
W B Omohundro	8	btne	700	Wlsn Rdair	—	8,000
Dwight M Ross Drlg Co	6	gas	750	Wlsn Atlas	750	7,000
Hemphill County						
Dillard-Waltermire Inc	9	gas	800	Natl 100	1200	13,500
Jack Grace Drlg Co	16	gas-btne	625	Wlsn Titan	1200	12,500
Parker Drlg Co	54	gas	—	Natl 125	1400	20,000
Henderson County						
Ace Drlg Co	4	gas-btne	400	Emsco G-500	630	9,000
M J Delaney Co	31	gas-btne	450	Wlsn Gnt Rdair	650	9,000
Travis Ward Drlg Co	2	dsl	1550	Wlsn Titan	1100	12,500
	3	gas-LPG	2000	Wlsn Spr Titan	1400	16,000
Hidalgo County						
Falco Drlg Co	2	gas	750	Ideco Super 750	700	9,500
Harkins & Co	6	gas-gaso	675	M-CSCO U-15	675	9,500
Monte Cristo Drlg Corp	1	gas-btne	750	Natl 50-A	700	8,500
	2	gas-btne	850	Emsco GA-500	700	8,500
	3	gas-btne	950	Natl 55	900	10,000
	4	gas-btne	600	TIW CT-5	700	8,000
	5	dsl	1200	Natl 80-B	1000	12,500
Viking Drlg Co	1	dsl	475	Natl 50	500	8,500
	2	dsl	475	Natl 50-A	500	8,500
John W Voss Drlg Co Inc	2	gas	750	Brwstr N-7	750	8,500
	3	gas	1400	Brwstr N-75	950	11,000
	4	gas	1600	Natl 100	1400	16,000
Hockley County						
Hewgley Drlg Co	5	dsl	—	Emsco J-750	975	11,000
Leatherwood Drlg Co	7	gas	650	Natl 50	—	10,000
Hopkins County						
Gibson Drlg Co	*1	gas	275	Wlsn Mogul 42	265	5,000
Houston County						
Maxwell Herring Drlg Corp	3	gas	—	Wlsn Gnt	—	10,000
W B Hinton	*3	dsl	500	M-CSCO U-15	900	9,000
Howard County						
Gardner Bros Drlg Co Inc	5	gas-btne	500	Natl 75	675	9,000
Norwood Drlg Co	2	gas-gaso	800	Wlsn Super Atlas	1000	12,500
Davey O'Brien Drlg Co Inc	1	gas-btne	700	Emsco GA-500	700	8,500
Wes-Tex Drlg Co	6	btne	500	M-CSCO U-15	640	8,500
Hunt County						
Maxwell Herring Drlg Corp	2	gas	—	Wlsn Gnt	—	11,000
Hutchinson County						
Alan Drlg Co	*2	gas	400	Wlsn Mogul	225	4,000
Canadian River Drlg Co	2	dsl	440	Wlsn Mogul	250	3,000
E B Clark Drlg Co	2	gas-btne	750	Wlsn Gnt	600	8,500
Kerr-McGee Oil Ind Inc	*34	dsl	300	Frnks LTX-5000	300	5,000
Moran Bros Inc	12	gas	350	Crdwll "S"	250	4,000
Jack County						
Bolin Oil Co & D H Bolin	6	LPG or NG	350	Wlsn Rdair Gnt	250	6,500
John W Harris Drlg Co	1	gas	500	Hou Prtble	450	6,500
	2	gas	500	Emsco GC-500	500	8,000
Lin-Mour Drlg Co	1	gas	315	Wlsn Mogul	400	4,600
E W Moran Drlg Co	1	gas	500	M-CSCO U-15	560	7,500
Jackson County						
Appell Petroleum Corp	3	gas-gaso	510	Brwstr N-4	225	6,000
Davis & Bates Inc	2	dsl	756	M-CSCO U-34	504	7,500
C J Foster Drlg Co Inc	2	gas	985	Brwstr N-75	750	12,000
Jasper County						
C J Foster Drlg Co Inc	2	gas	985	Brwstr N-75	750	12,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Avail-able to Drwwks	Rated Depth with 4½" Pipe
Jefferson County						
Clegg & Hunt	4	stm	—	Emsco H-54	—	11,000
	10	btne-gas	—	Natl 50-A	—	10,000
C J Foster Drlg Co Inc	*8	gas	800	Hou Port CT-5	600	9,500
Meredith & Co	*1	gas-gaso-btne	800	Emsco G-500	500	9,500
	3	gas-gaso-btne	1050	"Oilwell" 96	1100	14,000
Jim Hogg County						
Parker Drlg Co	58	gas	—	Natl 100	1400	14,000
Southland Drlg Co	*1	dsl	750	Emsco GA-350	650	8,500
Jim Wells County						
Appell Petroleum Corp	4	gas-gaso	630	Crdwll	370	7,000/3½"
Harkins & Co	2	dsl	300	Wlsn Gnt	300	6,500
Jones County						
Black Drlg Co	1	dsl	275	Frnks	250	4,000/3½"
Hondo Drlg Co	2	gas	450	M-CSCO U-15	450	5,500
Rhodes Drlg Co	10	gas	250	Failing 2500	290	2,500
Sojourner Drlg Corp	5	btne	225	Natl T-8-S	145	3,250
	11	btne	450	U-15	—	—
West Central Drlg Co	9	gas-btne	225	Spencer	145	4,200
Karnes County						
Buzzini Drlg Co	8	gas-prop	1670	Wlsn Titan	1220	14,000
Grey Wolf Drlg Co	2	dsl-elec	1534	Emsco ECA	1250	20,000
Holmes Drlg Co	1	gas-gaso	—	Beth ML-450	1000	11,000
	6	gas-gaso	—	Beth MC-450	700	10,000
	7	gas-gaso	—	Beth MC-450	1000	11,000
Hunt Drlg Co Inc	3	gas	965	Emsco GB-350	480	8,500
Miller Bros & Bowling	1	gas-btne	495	Emsco G-300	—	5,500
Kenedy County						
Stewart & Gouger Drlg Co	1	dsl	1500	Natl 130	1700	20,000
Kent County						
Empire Drlg Co	8	gas	500	M-CSCO U-15	675	9,000
Wes-Tex Drlg Co	9	btne	460	Emsco GA-500	570	9,000
Kerr County						
Wes-Tex Drlg Co	1	btne	650	Natl [illegible]	680	7,500
King County						
W B Omohundro	4	btne	450	Wlsn Mogul Torcair	—	6,500
Kleberg County						
Appell Petroleum Corp	2	dsl	685	Frnks SG-101	400	8,500
Chiles Drlg Co	5	gas	1700	Brwstr N-95	1500	14,000
Fitzpatrick Drlg Co	3	dsl	775	Brwstr N-7	700	8,500
J & C Drlg Co	5	dsl	1225	Wlsn Titan	1143	12,500
John W Voss Drlg Co Inc	1	gas	1200	Brwstr N-75	912	11,000
Knox County						
T V Gorman Drlg Contr	1	dsl	200	Wich R-3	200	3,000
Meredith Drlg Co	1	gas-btne	225 NK Wauk	Wlsn Spr	145 Wauk	3,500
Lafayette County						
Hamman Oil & Ref Co	6	dsl	250	Brwstr N-4	310	6,500
	7	dsl	340	Brwstr N-75	600	11,000
Lavaca County						
Stewart & Gouger Drlg Co	5	dsl	1500	M-CSCO C-914	1700	18,000
La Salle County						
J E Hillier	3	dsl	800	Crdwll KM-250	400	7,500/3½"
Leon County						
B G Byars Power Drlg Co	3	gas-btne	400	Emsco GA-250T	300	6,000
Liberty County						
Big "6" Drlg Co	2	gas-btne	700	M-CSCO U-15	700	11,000
Brewster-Bartle Drlg Co Inc	4	gas	—	"Oilwell" 76	—	11,000
Dillard-Waltermire Inc	2	dsl	1800	Natl 125	2400	16,000
Mac Drlg Co	10	gas-btne	1000	Natl 130	1300	20,000
Meredith & Co	4	gas-gaso-btne	1650	Brwstr N-75	860	11,500
Texdrill Corp	*1	gas-LPG	574	Brwstr N-4	300	6,500
Limestone County						
Thompson Expl Drlg Co	2	gaso	100	Failing 1500	100	1,500
Walters Drlg Co Inc (Dallas)	14	gas	—	Mayhew 1000	150	400/2⅞"
W W Wise Drlg Inc	1	gas	400	M-CSCO U-15	400	8,000
	2	dsl	550	Beth MC-450	550	9,000
Lipscomb County						
Big Chief Drlg Co	24	gas	750	M-CSCO U-15	800	9,500
Moran Bros Inc	4	gas	1000	Wlsn Titan	1200	14,000
Parker Drlg Co	47	gas	—	Natl 100	1400	14,000
Tradewinds Drlg Co	*64	gas-btne	—	Beth MC-450	700	10,000
Live Oak County						
General Well Drlg Inc	1	pwr	450	Wlsn Rdair	200	6,000/3½"
	7	dsl	650	Crdwll	300	7,500
Harkins & Co	3	gas-gaso	850	M-CSCO U-15	850	10,000
Allen & Morris Drlg Co	8	stm	1100	Emsco UB-LS-54	1200	12,000
Loving County						
Hissom Drlg Co	*12	gas-btne	—	M-CSCO U-34	650	6,500
Laughlin-Porter Drlg Co	7	gas	300	Wlsn Torqair	250	4,500
Leatherwood Drlg Co	2	gas	440	Natl T-32	—	7,000
	3	dsl	640	Natl T-20	640	6,000
	4	dsl	640	T-20	640	6,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Parker Drlg Co	42	gas	—	Natl 100	1400	14,000
Lubbock County						
Sitton & Norton Drlg Co	*2	gas-btne	680	Natl 75	680	11,000
Thompson Expl Drlg Co	1	dsl	184	Failing 2500	184	2,500
McMullen County						
Hunt Drlg Co Inc	2	stm	1200	Emsco UBLS-54	1200	11,000
Sutton Drlg Co Inc	4	dsl	—	Brwstr N-4	875	10,500
Marion County						
Tex-Mex Drlg Co	7	gas	—	Emsco GB-350	—	7,500
Martin County						
Davidson Drlg Co Inc	*A	gas-btne	1000	Emsco J-1250	1000	14,000
Llano Drlg Co	2	gas	—	Natl 100	975	14,000
B L McFarland Inc	5	gas	700	Brwstr N-75	700	12,000
Tri-Service Drlg Co	8	gas	900	"Oilwell" 76	900	10,000
Matagorda County						
Harry T Bryant Drlg Co Ltd	2	gas-btne	—	CT-5	800	9,000
	5	gas-btne	—	Beth M-58	1000	11,500
Clegg & Hunt	9	gas-btne	—	Natl 50-A	—	9,800
Columbia Drlg Co	2	gas-btne	1375	Natl 75	675	11,500
Edman Drlg Co	2	gas	1000	Brwstr N-75	900	12,000
C J Foster Drlg Co Inc	10	dsl	2150	Natl 125	1350	16,000
Hunt Drlg Co Inc	1	gas	1212	Brwstr N-7	732	10,000
Mac Drlg Co	7	stm	500	Natl 34-26	5000	10,000
	12	stm	500	Natl 23-9-FED	1000+	20,000
Neal Drlg Co	1	gas	1000	Natl 100	1000	13,500
Prince Marine Drlg & Exp Co	3	gas-btne	1200	Emsco A-550	950	10,500
Steen Drlg Co	1	stm	750	Emsco ECB	—	17,000
	3	btne-gas	700	Emsco J-750	1000	11,500
Triton Drlg Co	8	gas	500	M-CSCO U-15	800	10,500
Viking Drlg Co	4	gas-gaso	980	Ideco M-10,000	900	12,000
Maverick County						
Sutton Drlg Co Inc	3	dsl	—	Brwstr N-4	350	8,200
Menard County						
Rhodes Drlg Co	1	dsl	480	Natl T-20	480	5,500
Wes-Tex Drlg Co	7	btne	200	Crdwll D	225	3,000
Midland County						
B B M Drlg Co	2	gas-btne	1100	Emsco GB-800	1050	14,000/4"
	8	gas-btne	1050	Beth M-58	700	9000/4½"
Bayer-Hunefelt Drlg Co	2	gas-btne	350	Brwstr N-45	450	7,500
Henry Black Drlg Co	2	gas-gaso-btne	700	Natl 75	750	11,000
	6	gas-btne	550	M-CSCO U-15	700	8,500
Brantly Drlg Co Inc	4	gas	375	Beth S-55	480	6,500
Fryer & Hanson Drlg Co	4	gas-btne	1150	"Oilwell" 76	1200	12,000
	10	gas-btne	225	M-CSCO U-34	275	4,500
	11	gas-btne	1200	Beth M-58	1200	12,000
Great Western Drlg Co	11	dsl	353	Wlsn Gnt Rdmstr	900	9,000
Johnn Drlg Co	3	gas	650	Wlsn Atlas	900	10,000
Lowe Drlg Co	2	gas	750	Wlsn	750	10,000
McDonald Drlg Co	FP3	dsl	—	Failing	350	2,000
B L McFarland Inc	11	gas	2100	Grdnr-Den	2100	20,000
Davey O'Brien Drlg Co Inc	3	gas-btne	700	Emsco GB-500	700	9,000
Parker Drlg Co	28	gas	—	Natl 50	700	9,000
	64	gas	900	Natl 50-A	1000	9,000
Rowan Drlg Co Inc	28	gas-btne	1300	Natl 125	1530	15,000
Mitchell County						
Willard Gladson & Odstrcil Bros Drlg Co	*1	btne	—	B Erie 36-L	—	6,000
Montague County						
FWA Drlg Co Inc	15	—	—	—	—	3,000
H O Grace Drlg Co	4	btne	—	—	—	7,500
Orm Drlg Co	*15	dsl	—	—	600	7,500
C J Simpson Drlg Co	10	dsl-gas	—	Natl T-32	320	5,000
Montgomery County						
Harry T Bryant Drlg Co Ltd	4	gas-btne	—	Natl 75	1000	11,500
Keoughan Drlg Co Inc	1	dsl	556	Crdwll O	—	7,500
Motley County						
Thompson Expl Drlg Co	4	gas	184	Joy 275	184	2,500
	5	gaso	100	Failing 1500	100	1,500
Nueces County						
Allen & Morris Drlg Co	5	gas-btne	780	Emsco 76	900	12,000
Dan L Clark Drlg Co Inc	5	gas-btne	1025	Brwstr N-7	800	10,000
Dillard-Waltermire Inc	5	stm	800	Natl 23-9-FM	1000	12,000
J & C Drlg Co	6	gas-btne	485	Natl 50	380	7,500
	8	gas-btne	650	Beth 650	810	12,500
Nueces County						
J & C Drlg Co	*6	gas-btne	550	Natl 50	380	7,500
	8	gas-btne	810	Beth 650	810	12,500
Nolan County						
Dugger & Herring Drlg Co	1	dsl	—	Gdnr Den U-15	—	10,000
Fortune Drlg Corp	2	gas	600	M-CSCO U-15	600	7,500
Roy Guffey Drlg Co	6	gas-btne	500	M-CSCO U-15	500	7,500
Thomas & Duffield Drlg Co	7	gas-btne	—	Wlsn Gnt	600	7,000
West Central Drlg Co	8	gaso-btne	900	Wlsn Rdair	675	10,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Ochiltree County						
Arrow Drlg Co	9	gas	560	Emsco 500	700	8,500
Dillard-Waltermire Inc	10	gas	600	Wlsn Gnt	800	8,000
Lynn Drlg Co	2	gas-btne	425	Natl 75	700	10,000
FWA Drlg Co Inc	8	—	—	—	—	9,000
Jack Grace Drlg Co	5	gas-btne	500	Wlsn Atlas	700	10,000
Moran Bros Inc	11	gas	900	Wlsn Gnt	750	10,000
Rip C Underwood	1	gas-LPG	—	U-15	550	9,000
Wagner & Wyant Drlg Co Inc	4	gas-btne	500	M-CSCO U-15	700	9,000
Orange County						
Steen Drlg Co	4	gas-btne	1350	Ideco 1050	1350	16,000
Palo Pinto County						
Sojourner Drlg Corp	4	btne	225	M-CSCO U-34	225	4,500
Panola County						
J B Fletcher Drlg Co	4	gas-btne	300	Ideco H-30	—	5,500
Gibson Drlg Co	*5	gas	275	Wlsn Mogul 42	225	5,000
Scooter's Drlg Serv	2	dsl	300	Brwstr N-4	300	4,500
Parker County						
Graytex Drlg Co	1	gas	325	Natl T-32	400	6,500
Leatherwood Drlg Co	5	gas	220	Wlsn Gnt Rdair	—	6,000
Pecos County						
Bickerstaff & Tibbets Drlg Co	*4	gas	—	M-CSCO U-15	675	7,500
	*6	gas	—	M-CSCO U-15	675	8,500
Bolin Oil Co & D H Bolin	2	LPG or gas	250	Natl T-12	225	4,500
Brantly Drlg Co Inc	5	gas	375	Emsco 250	250	4,000
Coroco Drlg Co	1	gas-gaso	500	Beth 650	650	12,500
Delta Drlg Co	6	gas-btne	800	Emsco J-750	750	9,500
Great Western Drlg Co	44	dsl-elec	1400	M-CSCO U-1220	3000	25,000
Helmerich & Payne Inc	37	gas	1200	"Oilwell" 96	1450	15,000
E L Oliver Drlg Co	3	gas	200	Natl T-12 Trailer Mtd	185	3,000/4,000
Parker Drlg Co	43	gas	—	"Oilwell" 96	1400	15,000
	45	gas	—	Natl 125	1400	15,000
	65	gas	1200	Natl 100	1400	14,000
Western Serv Drlg Co Inc	*12	dsl	250	Natl T-20	520	4,000
Potter County						
Norwood Drlg Co	4	gas-gaso	500	Wlsn Gnt Rdair	600	9,500
Wagner & Wyant Drlg Co Inc	3	dsl	300	M-CSCO U-15	500	7,000
Presidio County						
Delta Drlg Co	36	gas-btne	900	Wlsn Titan	900	15,000
Reagan County						
Bolin Oil Co & D H Bolin	1	LPG or gas	250	Natl T-12	175	4,000
Frank Frawley Drlg Co	4	gas	—	M-CSCO U-40	840	10,500
Pool & Gerlich Drlg	D-3	gas	350	Emsco G-250	300	6,000
Tri-Service Drlg Co	5	gas	825	"Oilwell" 76	825	10,000
Reeves County						
Delta Drlg Co	3	gas-btne	900	Natl 100	800	12,000
Helmerich & Payne Inc	39	gas	1100	"Oilwell ' 96	1300	14,000
Hissom Drlg Co	*6	gas-btne	—	M-CSCO U-34	650	6,500
B L McFarland Inc	10	gas	500	Brwstr H-55	500	7,000
Parker Drlg Co	39	gas	—	Natl 100	1400	14,000
Thompson Expl Drlg Co	12	gaso	100	Mayhew 1000	100	1,000
Refugio County						
E L Bass Drlg Co	*3	rotary	—	M-CSCO U-34	—	7,000
Chiles Drlg Co	3	gas	500	Ideco H-40-D	460	8,500
J & C Drlg Co	2	stm	728	Ideal 34-32-9 DBM	525	10,000
	7	gas-btne	640	Emsco GB-500-34	645	9,000
Roberts County						
Arrow Drlg Co	11	dsl	595	Emsco 500	700	8,000
Moran Bros Inc	5	gas	1400	"Oilwell" 860	2025	17,000
Roberton County						
Gulley, Long & Hedge Drlg Co Inc	1	dsl	—	Beth Twstr	—	9,000
Roosevelt County						
Parker Drlg Co	59	gas	—	Natl 75	1000	11,000
Runnels County						
Frank Caraway Drlg Co	2	gas-btne	350	Wlsn Mogul Torcair	265	5,000
Low Drlg Co	1	btne	—	Emsco	290	7,000
Roy Guffey Drlg Co	4	gas-btne	500	M-CSCO U-15	500	7,500
Rusk County						
Robert M Bass Drlg Contr	1	gas-LPG	500	Wlsn Rdair	800	10,000
	2	gas-LPG	300	Wlsn Mogul	300	6,500
W Harlan Beene Drlg Co Inc	2	gas	685	Emsco GB-350	500	8,000
Gulley, Long & Hedge Drlg	*3	dsl	—	Beth Breeze	—	6,000
Nowery Drlg Co	*6	dsl	600	U-15	600	8,000
Travis Ward Drlg Co	1	dsl	600	Wlsn Gnt	300	6,500
San Patricio County						
Boyd & Durst Drlg Contr	2	gas-btne	650	Wlsn Gnt	700	8,500
Buzzini Drlg Co	9	gas-prop	1889	Wlsn Titan	1880	20,000
Schleicher County						
Fortune Drlg Corp	1	gas	512	Beth S-55-C	512	7,500
Hondo Drlg Co	6	gas	450	M-CSCO U-15	450	7,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Avail-able to Drwwks	Rated Depth with 4½" Pipe
Scurry County						
Forest Blackstock Inc	3	gas	650	Emsco 500	650	9,000
Brantly Drlg Co Inc	1	gas	365	Emsco 500	500	9,000
Coroco Drlg Co	6	gas-gaso	400	"Oilwell" 66	500	9,000
Dual Drlg Co	*1	gas	600	Wlsn Gnt	700	8,500
	*3	gas	600	Beth M-58	700	9,500
Willard Gladson & Odstrcil Bros Drlg Co	*2	btne	—	B-Erie 36 L	—	5,000
	*3	btne	—	B-Erie 28 L	—	4,500
Shackelford County						
Gore Drlg Co	1	dsl	640	Shovel Spl	—	7,500
	2	dsl	320	Beth	—	5,000
	3	gas	254	Joy 200-A	—	2,500/2⅛"
Smith County						
B C Byars Power Drlg Co	1	gas btne	1170	Beth MC-450	775	11,000
M J Delaney Co	24	gas-btne	500	Beth M-58	600	9,500
Delta Drlg Co	15	gas-btne	530	M-CSCO U-15	600	8,000
	42	dsl	600	M-CSCO U-15	550	8,500
Tex-Mex Drlg Co	5	gas-btne	600	M-CSCO U-15	600	9,000
	9	gas	400	Emsco 250	450	6,500
	12	gas	—	M-CSCO U-15	—	9,000
Starr County						
Gilmour Drlg Co	*3	dsl or gas	325	Natl T-32	400	6,000
Fitzpatrick Drlg Co	2	gas	950	M-CSCO U-40	900	10,000
Milam Drlg Co	1	gas-btne	600	Emsco G-500	600	8,000
Sutton Drlg Co Inc	10	dsl	—	Beth S-55	875	12,000
Stephens County						
Ewing Drlg Co	1	btne	—	Emsco C-42	450	4,500
Sheets & Walton Drlg Co	3	pwr	365	Brwstr N-4	285	5,000
Wes-Mor Drlg Inc	*4	gas-btne	465	M-CSCO U-34	225	6,000
Stonewall County						
Bolin Oil Co & D H Bolin	3	LPG or gas	350	Wlsn Gnt	250	5,000
	4	LPG or gas	350	Wlsn Rdair Gnt	350	7,500
Cooper Drlg Co	2	gas	600	Wlsn Gnt	600	8,000
Drillers Inc	U-15	dsl	—	M-CSCO U-15	600	7,200
FWA Drlg Co Inc	1	—	—	—	—	7,500
Roy Guffey Drlg Co	2	gas-btne	500	M-CSCO U-15	500	7,500
W B Omohundro	10	btne	300	Wlsn Super 38 Rdair	—	4,500/3½"
Sojourner Drlg Corp	3	dsl	550	M-CSCO U-15	520	7,500
Swisher County						
Norwood Drlg Co	3	gas-gaso	1050	Wlsn Titan	1050	12,500
Taylor County						
Cooper Drlg Co	1	gas	350	Natl 50	400	6,000
Dixon Drlg Co	3	gas	400	Natl 50	600	8,000
Hack Drlg Co	1	btne	—	M-CSCO U-15	412	8,500
	4	btne	—	—	161	2,500
Low Drlg Co	3	btne	—	Wlsn	165	2,500
Norman Drlg Corp	2	dsl	330	M-CSCO U-10	350	5,000
Rheay & Reynolds Drlg Co	6	gas	300	Natl 50	750	7,000
Robinson Drlg Co	2	btne	—	Crdwll E	—	5,000
	6	btne	—	Crdwll "O"	—	7,000
	8	btne	—	M-CSCO U-15	—	7,000
Sojourner Drlg Corp	1	btne	218	M-CSCO U-15	555	7,500
	2	dsl	320	M-CSCO U-15	265	5,000
Wes-Tex Drlg Co	2	btne	220	Brwstr N-4	400	5,500
Terrell County						
Great Western Drlg Co	18	gas	850	M-CSCO U-914A	1260	15,000
B L McFarland Inc	8	gas	700	Brwstr N-75	700	12,000
Parker Drlg Co	49	gas	—	Natl 125	1400	15,000
	63	gas	1200	Natl 100	1400	14,000
Rowan Drlg Co Inc	25	gas-btne	1260	Natl 100	1680	14,000
Throckmorton County						
Alan Drlg Co	*1	gas	500	Wlsn Gnt	600	7,600
Oney Drlg Co	*5	LPG	200	Crdwll "S"	166	4,500
R-G Drlg Co Inc	1	gas-gaso	—	Wlsn	650	6,500
	3	gas-gaso	—	Wlsn	450	6,500
	5	gas-gaso	—	Wlsn	650	8,000
Titus County						
W B Hinton	1	stm	—	ALCO-BIW DN-11	—	11,000
	*2	dsl	325	M-CSCO U-15	650	7,500
Tom Green County						
Herb Expl Co	2	btne	—	Failing 1500	—	1,500/2⅛"
Red River Drlg & Prod Co	*3	gas	235	M-CSCO U-34	185	4,500
Tyler County						
Clegg & Hunt	2	stm	—	Ideco Bg Gnt	—	15,000
Union County						
Thompson Expl Drlg Co	10	dsl	184	Failing 2500	184	1,000
Upton County						
Cactus Drlg Corp	9	gas	1185	Brwstr N-75	1185	12,000
E B Clark Drlg Co	1	gas-btne	750	Emsco G-500	600	7,500
Dixilyn Drlg Corp	3	gas	950	Natl 100	950	14,000
	4	gas	950	Natl 80	950	14,000
Llano Drlg Co	3	gas	1200	Natl 100	975	14,000
Valverde County						
Helmerich & Payne Inc	48	gas-btne	1200	Natl 110	1300	15,000
Hewgley Drlg Co	2	gas-btne	—	Ideco	1400	14,000
Van Zandt County						
Arrow Drlg Co	5	gas	1250	Emsco	1050	12,000
M J Delaney Co	30	gas-btne	500	Beth 1013	1200	15,000
Maxwell Herring Drlg Corp	5	gas	—	Wlsn Titan	—	14,000
Tex-Mex Drlg Co	10	gas	—	Emsco GB-500	—	9,000
Victoria County						
H H Howell	1	dsl	375	Frnks 5000	250	5,000
Hunt Drlg Co Inc	4	gas	846	Emsco GB-250	306	7,000
Ward County						
Bolin Oil Co & D H Bolin	7	LPG or NG	250	Beth S-50	225	4,000
Frank Frawley Drlg Co	5	gas	—	M-CSCO U-15	700	8,500
Hissom Drlg Co	*7	gas-btne	—	Card 405	—	5,000
B L McFarland Inc	*9	gas	285	Crdwll RL	185	4,000
	*14	gas	285	Crdwll RL	185	4,000
Norwood Drlg Co	1	gas-gaso	350	Wlsn Gnt Rdair	600	8,500
Webb County						
Allen & Morris Drlg Co	4	gas-btne	590	M-CSCO 50	450	9,000
Harkins & Co	4	gas-gaso	700	Wlsn Gnt	700	9,500
Wharton County						
Big "6" Drlg Co	3	gas-btne	500	Crdwll Trlg	500	7,500
Columbia Drlg Co	*5	dsl	750	M-CSCO U-15	450	8,500
Edman Drlg Co	3	dsl	1000	M-CSCO U-15	900	10,000
	*4	dsl	500	M-CSCO U-34	300	5,000
Wheeler County						
FWA Drlg Co Inc	13	—	—	—	—	4,500
Wichita County						
Akin & Dimock	2	dsl	300	Beth S-55	420	7,000
Bolin Oil Co & D H Bolin	5	LPG or NG	250	Wlsn Mogul	175	4,000
	9	LPG or NG	225	Wlsn Super	175	3,500
FWA Drlg Co	17	—	—	—	—	3,500
Hull Oil Co	1	btne	140	Wlkr-Nr R-2	135	2,150
Medford Drlg Co	1	gas-btne	200	Wichtex R-3	200	3,000
R-G Drlg Co Inc	2	gas-gaso	—	Wlsn	650	8,000

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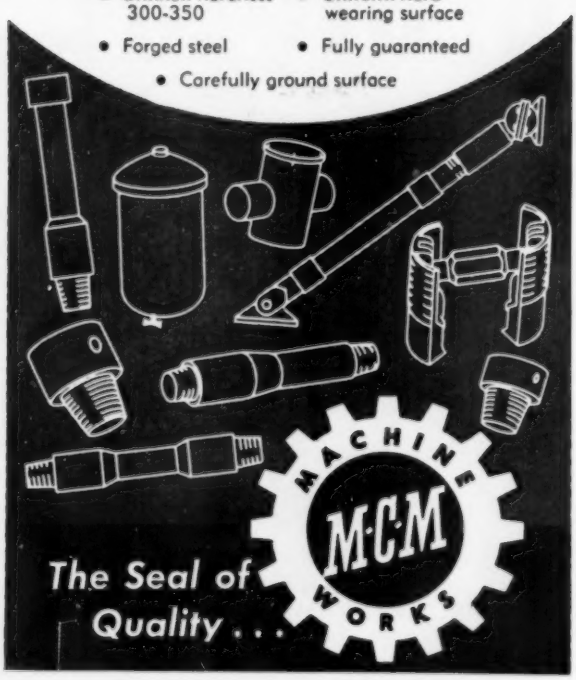

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Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Wilbarger County						
R Benton Ross Inc	1	dsl	225	Wlsn	165	4,000
FWA Drlg Co Inc	16	—	—	—	—	4,500
T V Gorman Drlg Contr	2	dsl	330	Wlsn 3B Torcair	300	4,500
Willacy County						
Allen & Morris Drlg Co	2	stm	1100	BIW 12	1200	14,000
Holmes Drlg Co	3	gas-gaso	—	Natl 110	1500	16,000
Winkler County						
B B M Drlg Co	6	gas-btne	1050	Emsco GB-500	650	10,000/3½"
Bickerstaff & Tibbets Drlg Co	*7	gas	—	Emsco G-36	450	5,500
Camden Drlg Co	1	dsl	300	Natl T-20	300	5,000
FWA Drlg Co Inc	3	—	—	—	—	10,000
Frank Frawley Drlg Co	3	gas	—	Natl 100	1035	13,500
Frontier Drlg & Prod Co	*8	dsl	350	N-4 Brwstr	300	4,000
Gardner Bros Drlg Co Inc	*20	gas-btne	275	Natl T-25	350	4,000
Great Western Drlg Co	7	gas	375	Natl T-20	310	4,000
Llano Drlg Co	5	gas	1070	Natl 100	1050	14,000
Leatherwood Drlg Co	1	dsl	1560	Ideco 7-11	1560	15,000
B L McFarland Inc	*4	gas	285	Crdwll RL	185	4,000
Pool & Gerlich Drlg	D-1	gas	260	M-CSCO U-34	300	5,000
Wise County						
Gateway Petro Co Inc	U-15	gas	—	—	—	7,000
Luke Grace Drlg Co	6	dsl	270	Wlsn Gnt	270	6,500
John W Harris Drlg Co	1	gas	500	Hou Prtble	450	6,500
	2	gas	150	Wlsn Super	150	3,500
Holliman Drlg Co	3	gas	255	M-CSCO U-15	600	7,500
T & O Drlg Co	1	gas	340	M-CSCO U-34	230	5,000
Trio Drlg Co	1	gas	520	Natl 50	—	6,500
	2	gas	520	Natl 50	—	6,500
	3	gas	450	Natl 50	—	6,500
	4	gas	450	Natl 50	—	6,500
Walters Drlg Co Inc (Dallas)	12	dsl	—	Mayhew 1000	300	400/2⅛"
Wood County						
Ace Drlg Co	2	gas-btne	500	Emsco G-500	740	9,000
M J Delaney Co	19	gas-btne	600	Emsco J-1250	1200	15,000
Delta Drlg Co	22	gas-btne	530	M-CSCO U-15	600	8,000
	40	gas-btne	325	Wlsn Rdr Gnt	690	8,000
	44	gas-btne	1300	Brwstr N-95	1300	14,000
Parker Drlg Co	38	gas	—	Natl 100	1000	14,000
Yoakum County						
Cactus Drlg Corp	3	gas	1485	Natl 80-B	1485	14,000
Durham Drlg Co Inc	1	gas	650	M-CSCO U-15	650	8,000
Empire Drlg Co	*2	gas	550	Brwstr N-7	750	9,500
Great Western Drlg Co	2	gas-gaso	500	Wlsn Gnt Rdmstr	840	9,000
H O Grace Drlg Co	1	btne	—	—	—	6,000
Lowe Drlg Co	1	gas	500	M-CSCO U-15	500	7,500
Moran Oil Prod & Drlg Corp	1	gas	—	M-CSCO U-15	800	8,500
Sitton & Norton Drlg Co	*1	btne-gas	380	Wlsn Gnt	380	5,600
Young County						
Jess P Cross Drlg Contr	*1	gas-btne	225	Wlsn Gnt	200	4,800
J W Hastings Drlg Co	4	gas-btne	330	Wlsn Torcair	220	5,000
	5	gas-btne	864	Wlsn Gnt Rdr	864	8,200
Gene McCutchin Drlg Co	*5	gas	275	Wlsn Gnt	275	5,500
	8	gas	550	Natl 50	550	8,000
Meredith Drlg Co	2	gas-btne	675	Wlsn Gnt 3x225	NK Wauk	7,500
Wes-Mor Drlg Inc	*5	gas-btne	225	Wlsn Mogul	225	3,500
Zapata County						
Longhorn Drlg Corp	*5	gas-btne	500	M-CSCO U-15	675	9,500
	*6	gas-btne	700	"Oilwell" 76	1185	14,000
Well Drlrs Inc	1	gas-btne	1446	Brwstr N-95	1446	16,000
	2	gas-btne	1446	Super 7-11 Ideco	1446	15,000
Zavala County						
Dixon Drlg Co	*4	dsl	200	Natl T-12	200	4,000
West Central Drlg Co	5	gas-btne	1000	M-CSCO U-15	700	9,000
UTAH						
Emery County						
Will I Lewis Drlg Co	5	dsl	1200	"Oilwell" 76	1200	13,500
Moran Bros Inc	1	gas	1000	"Oilwell" 760	1200	14,000
Grand County						
Mountain States Drlg Co Inc	3	gas-dsl	600	Natl 50-A	—	7,500
Willard Pease Drlg Co	1	dsl	340	Stratmaster 90	320	5,500/3½"
San Juan County						
Calvert Drlg Inc	15	dsl	260	Ideco H-35	260	7,000
	20	dsl	350	Ideco H-525	600	8,500
	23	dsl	350	Ideco H-525	600	8,500
Arapahoe Drlg Co	7	gas-btne	700	Natl T-45	700	8,500
Kent Drlg Co	1	gas	—	Natl 75 CE	1050	10,500
R L Manning Co	4	gas-btne	600	Emsco 450	450	7,000
Moran Bros Inc	7	gas	1100	Wlsn Gnt	1000	12,000
	9	gas	700	"Oilwell" 66	750	9,500
Nichols Drlg Co	*3	gas	—	—	—	8,500
Rhodes Drlg Co	5	gas	450	M-CSCO U-15	675	9,000
Rutledge Drlg Co	*5	gas-btne	692	Natl 50	500	8,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Sanpete County						
Pioneer Drlg Co Inc	*5	dsl	960	Emsco J-750	960	12,000
Uintah County						
Arapahoe Drlg Co	3	gas-btne	300	Wisn Mogul	275	5,000
Colorado & Western Drlg Co	3	LP gas	225	Natl T-32	400	6,500
Gist Expl Co	3	gas-btne	1200	M-CSCO U-20	1425	12,000
Hose-Austin Drlg Corp	1	dsl	350	Emsco GB-250T	450	6,000
Kerr-McGee Oil Ind Inc	1	gas	825	M-CSCO U-15	832	10,000
	23	gas	650	Natl 50	556	9,000
Wayne County						
Great Western Drlg Co	23	dsl	500	M-CSCO U-15	800	9,000
WEST VIRGINIA						
Doddridge County						
Houchins Drlg Co	1	dsl	300	Natl T-20	300	4,500
Greenbrier County						
Delta Drlg Co	39	gas-btne	700	Natl 75	900	12,000
Preston County						
Delta Drlg Co	29	dsl	700	Emsco J-750	1000	12,000
Randolph County						
Lohmann-Johnson Oil Co Inc	10	dsl	—	M-CSCO U-15	500	6,000
S W Jack Drlg Co	4	gas	1000	M-CSCO U-15	1000	10,000
WYOMING						
Big Horn County						
Will I Lewis Drlg Co	6	dsl	1600	M-CSCO U-20	1600	14,000
Campbell County						
D-K Drlg Co	1	gas-btne	675	Natl 50	675	7,500
	2	gas-btne	675	Natl 50	675	7,500
Delta Drlg Co	23	dsl	520	Emsco GA-500	500	8,000
Exeter Drlg Co	1	dsl	500	Emsco GA-350	630	7,000
Pioneer Drlg Co Inc	3	dsl	960	Emsco GA-500	640	9,500
	*4	dsl	960	Emsco GB-500	640	9,500
Roden & McRae Drlg Corp	*5	gas	360	Emsco GA-250T	425	6,500
Signal Drlg & Expl Inc	8	gas	250	Natl 50	700	8,000
Tradewinds Drlg Co	5	dsl	—	Emsco GA-250T	290	6,500
True Drlg Co	9	gas-LPG	1200	M-CSCO U-40	1200	13,000
	11	gas-LPG	1100	Natl 75	1100	11,000
	12	gas-LPG	1200	Wisn Gnt	800	13,000
	14	gas-LPG	1000	Natl 50-A	700	9,500
Carbon County						
Delta Drlg Co	18	dsl	600	Natl 75	650	9,500
Mountain States Drlg Co Inc	2	gas-dsl	1000	Emsco J-750	—	10,000
Rowan Drlg Co Inc	5	gas-btne	505	Natl 75	1010	11,000
Signal Drlg & Expl Inc	9	gas	250	Brwstr N-45	500	7,000
Converse County						
Big Horn Drlg Co Inc	3	gas	600	Emsco GB-250	360	6,500
Bueno Drlg Co	1	dsl	720	Natl T-20	300	5,000
Crook County						
Delta Drlg Co	43	dsl	400	M-CSCO U-10	450	6,000
Exeter Drlg Co	5	dsl	300	Natl T-32	300	6,000
True Drlg Co	6	gas-LPG	1000	Beth Twstr	750	8,500
	8	gas-LPG	750	Natl 50	500	7,500
	10	gas-LPG	1000	M-CSCO U-15	675	8,500
Fremont County						
Fitzpatrick Drlg Co Inc	4	gas-btne	900	Wisn Titan Rdr	900	12,500
Gabe McCall Drlg Co	2	dsl	600	Emsco GB-250	360	6,500
Roden & McRae Drlg Corp	*6	dsl	275	Frnks Rokt TD-44	275	2,000
Signal Drlg & Expl Inc	10	gas	250	Emsco G-500	785	8,500
Tradewinds Drlg Co	6	dsl	—	Frnks TD-44	220	3,500
Hot Springs County						
Arrow Drlg Co	14	gas	600	Emsco T-250	—	4,500
R L Manning Co	10	gas-btne	1275	Emsco J-750	1125	11,000
Lincoln County						
Hewit-Gulick Drlg Co	2	dsl	970	Natl 80	900	12,000
	3	dsl	855	Natl 50-A	900	9,000
Natrona County						
D-K Drlg Co	3	gas-btne	450	Natl 50	450	6,500
Fitzpatrick Drlg Co Inc	3	dsl-btne	300	Natl T-20	200	5,500
	6	dsl	300	Natl T-12-S	300	4,500
Garvey Drlg Co	17	dsl	300	Wisn Rdair	450	7,000/3½"
R L Manning Co	8	dsl	550	Emsco G-500	550	7,500
	11	gas-btne	1080	Emsco J-1000	1305	13,000
	15	dsl	540	Emsco GB-250	340	6,000
	17	gas-btne	765	Emsco GC-500	840	10,000
Rowan Drlg Co Inc	31	gas-btne	900	Natl 75	1149	11,000
J D Sprecher	6	dsl	750	Emsco A-550	750	10,000
Niobrara County						
A L Schlaikjer	1	gas	800	Wisn Gnt Rdair	800	8,500
True Drlg Co	*7	dsl	350	Failing 66	185	3,000
Park County						
Big Horn Drlg Co Inc	1	dsl	320	Brwstr N-4	290	5,500
C E Brehm Drlg & Prod	W-3	gas	532	Wisn Mogul Spr	532	7,200
R L Manning Co	5	gas-btne	750	Emsco G-500	750	8,000
	16	gas-btne	650	Natl T-32	450	6,000
	18	gas-btne	600	Emsco GB-250	440	6,500
Rowan Drlg Co Inc	24	gas-btne	504	Natl 50	1077	8,500
Signal Drlg & Expl Inc	3	dsl	475	M-CSCO	500	7,500
Platte County						
Midland Expl Co Inc	1	gas	650	M-CSCO U-15	—	9,000
Rock Springs County						
Nye & Snell Drlg Co	3	gas	600	Wisn Atlas	800	11,000
Sheridan County						
Hose-Austin Drlg Corp	2	dsl	300	Natl T-32	320	5,500
Sublette County						
Fitzpatrick Drlg Co Inc	1	gas-btne	550	M-CSCO U-15	550	8,250/4"
Gist Expl Co	2	gas-btne	800	Brwstr N-75	950	10,000
	4	gas-btne	620	Wisn Gnt Rdair	750	8,000
Kent Drlg Co	2	gas	—	Natl 50	1200	7,500
Sweetwater County						
Camay Drlg Co Rocky Mt Div	3	dsl	560	Natl 50-A	450	8,500
Fitzpatrick Drlg Co Inc	5	gas-btne	600	Natl 50-A	600	8,500
Hewit-Gulick Drlg Co	1	dsl	970	Natl 50-A	600	8,000
	4	dsl	370	Natl T-32	356	6,000
Roden & McRae Drlg Corp	*1	dsl	625	Emsco GA-350	570	7,000
J D Sprecher	2	dsl	900	Emsco J-750	900	10,500
	4	dsl	1000	Natl 80-B	1000	14,000
	5	dsl	350	Brwstr N-45	350	6,500
Tradewinds Drlg Co	1	dsl	—	Emsco GA-350	615	7,500
Uinta County						
Pioneer Drlg Co Inc	*6	dsl	960	Emsco GB-800	960	13,000
Signal Drlg & Expl Inc	6	gas-btne	1000	Natl 100	1000	13,500
Weston County						
Garvey Drlg Co	19	dsl	300	Wisn Rdair	450	7,000/3½"
Lohmann-Johnson Drlg Co Inc	4	dsl	300	M-CSCO U-15	440	5,500
Olds & Wrather Drlg Co	1	dsl	300	Wisn Rdair Mogul	300	5,000
Marfin Drlg Co	5	dsl	500	Emsco C-500	600	8,000
Olds & Wrather Drlg Co	3	btne	400	Frnks Comet	300	5,000
	4	btne	800	Beth 450	800	10,000
	2	dsl	450	Natl 50	450	7,000
Prairie Drlg Co Inc	1	gas	—	Crdwll RL Spdr	200	11,000

Canadian Rotary Drilling Contractors

Bawden Peter Drlg Ltd 640 Seventh Ave Calgary Alberta Canada
Big Horn Drlg Ltd 6530 100th St Edmonton, Alberta, Canada
Big Indian Drlg Co Ltd 216 Blow Bldg 513 8th Ave W Calgary Alberta Canada
Brinkerhoff Drlg Co Ltd 1001 Mobil Oil Bldg Calgary Alberta Canada

Can American Drlg Ltd 320 Seventh Ave W Calgary Alberta Canada
Canbridge Corp Ltd Calgary Alberta Canada
Cascade Drlg Co Ltd 330 Ninth Ave SW Calgary Alberta Canada
Commonwealth Drlg Co Ltd 122 Eighth Ave W Calgary Alberta Canada
Coultis Drlg Ltd 1724 Suffolk St Calgary Alberta Canada

Double-A Drlg Co Ltd 709 Eighth Ave W Calgary Alberta Canada
Duke Drlg Co Ltd 239 Eighth Ave W Calgary Alberta Canada

Gardner Bros Drlg Co Ltd 309 7th Ave SW Calgary Alberta Canada
Gardner Bros Drlg Co Inc 1718 Davis Bldg Dallas Tex
General Petroleums Drlg Co Ltd 224 Ninth Ave W Calgary Alberta Canada
Gustavson Drlg Co Ltd 203 Empire Bldg Calgary Alberta Canada

Hewgley Drlg Co of Canada Ltd 809 Centre St S Calgary Alberta Canada
Hi-Tower Drlg Co Ltd 400 Lancaster Bldg Calgary Alberta Canada
Hunter Drlg Ltd 602 Seventh Ave W Calgary Alberta Canada

L & J Drlg Ltd 7 Empire Bldg Calgary Alberta Can
R E Lee Drlg Co Ltd 300 Lancaster Bldg Calgary Alberta Canada
Lohmann-Johnson Drlg Co Ltd 208 Bamlett Bldg Calgary Alberta Canada

Mortenson Drlg 8706-83 Avenue Edmonton Alberta Canada

Parker Drlg Co of Canada Ltd 409 Eighth Ave W Calgary Alberta Canada
Pennant Drlg Co Ltd 132—9 Street SW Calgary Alberta Canada
Petrolia Drlg Co Ltd 1410 4th St SW Calgary Alberta Canada
Porter Drlg Ltd 304 Brent Bldg Regina Saskatchewan Canada

Reading & Bates Drlg Co Ltd Royal Bk Bldg Calgary Alberta Canada
Regent Drlg Co Ltd Box 421 Edmonton Alberta Canada
Ryland Drlg Ltd Box 608 Edmonton Alberta Canada

S & T Drlg Co Ltd 10852 82nd St Edmonton Alberta Canada

Trinity Canadian Drlg Co 1001 F R Webster Bldg 237 Seventh Ave W Calgary Alberta Canada

Canadian Contract ROTARY Drilling Rigs

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
(Undesignated)						
Big Indian Drlg Co Ltd	3	gas	—	Mayhew		2,000/2⅛"
	4	gas	—	Mayhew		2,000/2⅛"
	7	gas	—	Mayhew	—	1,000/2⅛"
	6	gas	—	Mayhew	—	1,000/2⅛"
	8	gas	—	Mayhew	—	2,000/2⅛"
	11	gas	—	Mayhew	—	1,500/2⅛"
Hewgley Drlg Co of Canada Ltd	1	dsl	1000	Emsco A-800	1550	16,000
	3	dsl	625	Emsco J-750	950	12,000
ALBERTA						
(Undesignated)						
Canamerican Drlg Corp Ltd	*2	dsl	650	Natl 55	975	12,000
	*3	dsl	1200	Natl 110	1600	15,000
Gardner Bros Drlg Co Inc	15	gas-btne	1000	"Oilwell" 96	1500	16,000
Hi-Tower Drlg Co Ltd	1	dsl	525	"Oilwell" 66	850	10,000
	2	dsl	600	Crdwll "G"	700	8,000
	3	dsl	525	"Oilwell" 66	800	9,500
	4	dsl	350	Natl 50-A	600	8,500
	6	dsl	755	"Oilwell" 76	900	12,000
	7	dsl	525	"Oilwell" 66	875	10,000
	8	dsl	570	M-CSCO U-15	600	7,000
	9	dsl	285	Crdwll D	300	5,500
	10	dsl	755	"Oilwell" 76	1000	12,000
	12	dsl	375	Crdwll 201	300	6,000
	15	dsl	400	Crdwll 201	300	6,000
Lohmann-Johnson Drlg Co Ltd	1	dsl	550	"Oilwell" 66	550	9,000
	2	dsl	228	M-CSCO U-15	500	9,000
Petrolia Drlg Ltd	7	dsl	250	Natl 50	365	7,500
	10	dsl	300	M-CSCO U-34-D	300	5,500
	11	dsl	950	M-CSCO U-40	1050	12,000
Airdrie						
Peter Bawden Drlg Ltd	25	dsl	556	"Oilwell" 66	556	8,000
Alexander Falls						
Regent Drlg Co Ltd	21	dsl	260	Brwstr N-4	260	9,000/3½" 6,000/4½"
Alhambra						
Parker Drlg Co of Canada Ltd	6	dsl	420	Natl 50	420	6,500
Atwater						
Regent Drlg Co Ltd	22	dsl	260	Brwstr N-4	260	6,000
Bentley						
Duke Drlg Co Ltd	9	dsl	500	M-CSCO U-15	650	9,000
Bistahko Lake						
Commonwealth Drlg Co Ltd	17	dsl	630	Emsco GB-350	720	6,000
Bragg Creek						
Duke Drlg Co Ltd	6	dsl	850	M-CSCO U-20	1386	15,000
Brazeau Creek						
Duke Drlg Co Ltd	7	dsl	850	M-CSCO U-20	1386	15,000
Breton						
Ryland Drlg Ltd	3	dsl	320	Natl T-32	320	6,000
Calgary						
Peter Bawden Drlg Ltd	23	dsl	627	Emsco GB-350	627	7,000
Big Indian Drlg Co Ltd	*14	gas	—	Failing	—	2,000/2⅛"
Calling Lake						
Big Horn Drlg Ltd	*1	dsl	300	Crdwll S-350	300	5,000
Caistau Meekwap						
Parker Drlg Co of Canada Ltd	3	dsl	765	"Oilwell" 76	1005	12,000
Carstairs						
Gen Petroleums Drlg Co Ltd	4	dsl	800	Natl 50-A	650	7,500
Central						
Canbridge Corp Ltd	*1	dsl	380	Crdwll trl	380	6,000
	*5	dsl	200	Crdwll L	200	4,500
	6	dsl	420	Emsco GB-350	420	7 500
	*9	dsl	300	Crdwll L	200	5,000
	10	dsl	400	Frnks SAL	400	5,000
	11	dsl	300	Emsco G-300	300	6,000
Cessford						
Cascade Drlg Co Ltd	6	dsl	556	Natl T-20	233	4,500
	16	dsl	278	M-CSCO U-34	311	5,000
Hunter Drlg Ltd	3	dsl	450	Crdwll	260	6,000
Chinchaga River						
Peter Bawden Drlg Ltd	11	dsl	278	Natl T-32	278	6,000
Crossfield						
Commonwealth Drlg Co Ltd	8	dsl	690	Brwstr N-7	600	8,000
Gustavson Drlg Co Ltd	3	dsl	275	Ideco H-40	300	6,500
Regent Drlg Co Ltd	6	dsl	750	Brwstr N-75	780	10,000
	28	dsl	500	Natl 50-A	520	7,500
Coutts						
Gardner Bros Drlg Co Ltd	15	dsl	1600	"Oilwell" 96	2000	18,000
R E Lee Drlg Co Ltd	*1	dsl	270	Natl T-20	270	4,500
Crossfield						
Gen Petroleums Drlg Co Ltd	6	dsl	400	Natl 50-A	550	7,500
	14	dsl	400	Crdwll OA	550	7,500
Didsbury						
Gen Petroleums Drlg Co Ltd	15	dsl	1400	Natl 55	1050	10,000
Donalda						
Double-A Drlg Co Ltd	11	dsl	320	Ideco H-30	300	5,000
Drayton Valley						
Ryland Drlg Ltd	1	dsl	600	Emsco 450	640	7,500
Duchess						
Gen Petroleums Drlg Co Ltd	21	dsl	250	M-CSCO U 34-D	275	4,800
Duvernay						
Big Horn Drlg Ltd	*3	dsl	300	Crdwll 1-350	300	4,500
Edmonton						
Peter Bawden Drlg Ltd	4	dsl	227	Crdwll RL	210	4,500
Cascade Drlg Co Ltd	8	dsl	556	Natl 50	556	6,500
	21	dsl-elec	1160	Natl	1160	13,000
Mortenson Drlg	3	gas	—	Failing	110	1,000
Edson						
Gardner Bros Drlg Co Ltd	7	dsl	970	Natl 75	1000	13,000
Ferrier						
Gen Petroleums Drlg Co Ltd	5	dsl	1400	Natl 80-B	1400	13,000
Fina Pine						
Pennant Drlg Co Ltd	5	dsl	1050	M-CSCO U-40	—	12,000
Forestburg						
Double-A Drlg Co Ltd	13	dsl	320	Ideco H-40	300	6,500
Fox Creek						
Gen Petroleums Drlg Co Ltd	7	dsl	1400	Natl 80-B	1300	13,000
Garrington						
Gustavson Drlg Co Ltd	1	dsl	500	Natl 50	500	7,500
Gilboy						
Commonwealth Drlg Co Ltd	14	dsl	580	Ideco H-40-D	660	5,500
Hand Hills						
Gen Petroleums Drlg Co Ltd	20	dsl	400	Emsco GB-250	275	5,500
Harmatton						
Commonwealth Drlg Co Ltd	9	dsl	1020	Ideco 700	940	10,000
	28	dsl	920	Natl 55	1000	10,000
Gen Petroleums Drlg Co Ltd	3	dsl	1250	Natl 55	1000	10,000
	10	dsl	1400	Natl 80	1000	11,000
Harmon Valley						
Commonwealth Drlg Co Ltd	10	dsl	550	Ideco H-35-D	300	6,500
Hotchkiss						
Regent Drlg Co Ltd	2	dsl	520	Brwstr N-55	520	8,500
Hudson Bay						
Parker Drlg Co of Canada Ltd	5	dsl	420	Natl 50	420	7,000
Jeffre						
Gen Petroleums Drlg Co Ltd	12	dsl	400	Natl T-20	275	4,800
Judy Creek						
Peter Bawden Drlg Ltd	2	dsl	834	Natl 55	834	10,000
	20	dsl	834	"Oilwell" 76	834	11,500
Brinkerhoff Drlg Co Ltd	18	dsl	625	Emsco GC-500	846	10,000
Commonwealth Drlg Co Ltd	27	dsl	870	Natl 50-A	660	9,000
Duke Drlg Co Ltd	8	dsl	500	M-CSCO U-40	670	11,500
Parker Drlg Co of Canada Ltd	7	dsl	600	Natl 55	670	9,000
Regent Drlg Co Ltd	24	dsl	720	Brwstr N-7	520	9,000
S & T Drlg Co Ltd	3	dsl	600	Natl 55	1083	11,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Kaybob						
Peter Bawden Drlg Ltd	26	dsl	834	"Oilwell" 76	834	11,500
Duke Drlg Co Ltd	5	dsl	700	M-CSCO U-20	1386	15,000
Gustavson Drlg Co Ltd	6	dsl	1000	Emsco A-550	1000	11,000
Kaydee						
Brinkerhoff Drlg Co Ltd	22	dsl	900	Natl 110	1450	15,000
Kenai						
Reading & Bates Drlg Co Ltd	6	dsl	1200	Natl 80-B	12,000	14,000
Leafland						
Peter Bawden Drlg Ltd	5	dsl	454	Natl T-32	278	5,500
Lethbridge						
Coultis Drlg Ltd	1	dsl	248	Ideco H-25-D	248	3,500
Limestone Mountain						
Peter Bawden Drlg Ltd	10	dsl	1120	Natl 80-B	1120	14,000
Lobstick						
Brinkerhoff Drlg Co Ltd	16	dsl	370	Emsco GA-350	450	7,500
Cascade Drlg Co Ltd	10	dsl	556	Natl 50	556	6,500
Gen Petroleums Drlg Co Ltd	19	dsl	400	Natl T-32	275	5,500
Lookout Butte						
Brinkerhoff Drlg Co Ltd	19	dsl	850	Emsco A-800	1269	14,000
	21	dsl	850	Emsco GB-800	1269	13,500
	27	dsl	850	Natl 100	1270	13,500
Mahon Creek						
Peter Bawden Drlg Ltd	18	dsl	1290	Natl 100	1290	13,000
Marten Hills						
Parker Drlg Co of Canada Ltd	11	dsl	400	Natl 50	500	6,500
Midale						
Regent Drlg Co Ltd	23	dsl	260	Brwstr N-4	260	6,000
	27	dsl	260	Brwstr N-4	260	6,000
Moose Mountain						
Commonwealth Drlg Co Ltd	26	dsl	1275	Natl 80-B	1410	12,000
Okotoks						
Commonwealth Drlg Co Ltd	6	dsl	690	Ideco M-750	600	8,500
Parkland						
Gen Petroleums Drlg Co Ltd	11	dsl	1400	Natl 80-B	1400	13,000
Peace River						
Canbridge Corp Ltd	*3	dsl	380	Crdwll TRL	380	6,000
Pembina						
Peter Bawden Drlg Ltd	1	dsl	415	Natl T-32	305	5,500
	12	dsl	278	Natl T-12	159	4,000
Brinkerhoff Drlg Co Ltd	12	dsl	300	Natl T-32	300	6,800
Cascade Drlg Co Ltd	3	dsl	556	Natl 50	278	6,500
Commonwealth Drlg Co Ltd	11	dsl	260	Ideco H-40-D	300	5,500
	25	dsl	425	M-CSCO U-34D	300	5,500
Gustavson Drlg Co Ltd	2	dsl	500	Natl T-32	250	6,500
Regent Drlg Co Ltd	1	dsl	260	Brwstr N-4	260	6,000
	26	dsl	260	Ideco H-40	260	7,500
	29	dsl	260	Brwstr N-4	260	6,000
	30	dsl	260	Ideco H-40	260	6,000
S & T Drlg Co Ltd	1	dsl	470	Natl 50-A	648	8,500
	2	dsl	220	Natl T-32	275	6,000
Penhold						
Big Indian Drlg Co Ltd	*10	gas	—	Mayhew	—	2,000/2½
Pincher						
Brinkerhoff Drlg Co Ltd	8	dsl	900	Natl 110	1200	15,000
Pine Creek						
Pennant Drlg Co Ltd	6	dsl	1050	M-CSCO U-40	—	12,000
Red Deer						
Chupp Well Serv Ltd	*5	—	—	Ideco M-25-D	—	10,000
Rimbey						
Hunter Drlg Ltd	2	dsl	900	Crdwll J-700	1150	12,000
Pennant Drlg Co Ltd	2	dsl	900	Brwstr	900	10,000
Regent Drlg Co Ltd	10	dsl	480	M-CSCO U-36	480	8,500
St. Albert						
Ryland Drlg Ltd	2	dsl	670	Natl 50	690	7,500
Gen Petroleums Drlg Co Ltd	1	dsl	400	Natl 50-A	550	7,500
Shell House Mountain						
Parker Drlg Co of Canada Ltd	13	dsl	840	Crdwll "OA"	840	9,000
Shell West Jumping Pound						
Parker Drlg Co of Canada Ltd	9	dsl	1260	Natl 110	1890	16,000
Simonette						
Peter Bawden Drlg Ltd	15	dsl	834	M-CSCO U-40	834	11,500
	22	dsl	834	"Oilwell" 76	834	11,500
Cascade Drlg Co Ltd	12	dsl	1350	Natl 80-B	1350	14,000
Reading & Bates Drlg Co Ltd	2	dsl	1000	Natl 55	1000	12,000
Slave Lake						
Duke Drlg Co Ltd	2	dsl	650	Natl 50	650	8,000
Smokey River						
Pennant Drlg Co Ltd	4	dsl	1050	Crdwll "O"	—	9,500
Snipe Lake						
Regent Drlg Co Ltd	9	dsl	750	Brwstr N-75	780	10,000
South Edson						
Peter Bawden Drlg Ltd	21	dsl	1680	"Oilwell" 96	1680	18,000
Southern						
Canbridge Corp Ltd	7	dsl	780	Crdwll "O"	780	9,000
Sundre						
Cascade Drlg Co Ltd	14	dsl	1350	M-CSCO U-20	1350	14,000
Swan Hills						
Peter Bawden Drlg Ltd	6	dsl	720	M-CSCO U-36A	720	8,500
	7	dsl	832	Natl 55	832	10,000
Brinkerhoff Drlg Co Ltd	15	dsl	500	Natl 50-A	600	8,500
Canbridge Corp Ltd	12	dsl	670	Emsco GB-500	670	9,000
Cascade Drlg Co Ltd	1	dsl	556	Natl 50	556	6,500
	17	dsl	1190	Natl 75	1190	12,000
	20	dsl	834	Emsco J-750	834	11,000
Commonwealth Drlg Co Ltd	21	dsl	1250	Ideco 7-11	900	10,500
Parker Drlg Co of Canada Ltd	2	dsl	800	"Oilwell" 76	1275	11,500
	12	dsl	650	"Oilwell" 66	800	9,000
Reading & Bates Drlg Co Ltd	1	dsl	1000	Natl 75	1000	10,000
	3	dsl	1000	Natl 75	1000	12,000
Regent Drlg Co Ltd	3	dsl	720	Brwstr N-7	520	9,000
	25	dsl	750	Brwstr N-75	780	10,000
Talbot Lake						
Gen Petroleums Drlg Co Ltd	25	dsl	375	Emsco GA-250	275	5,500
Trochu						
Commonwealth Drlg Co Ltd	7	dsl	750	Natl 50	530	6,500
Vegreville						
Big Horn Drlg Ltd	*2	dsl	250	Crdwll L	180	3,500
Virgina Hills						
Peter Bawden Drlg Ltd	9	dsl	1000	M-CSCO U-40	1000	11,500
Brinkerhoff Drlg Co Ltd	1	dsl	625	Emsco GC-500	846	10,000
Commonwealth Drlg Co Ltd	16	dsl	800	Emsco GB-350	720	7,000
	19	dsl	735	Natl 50-A	790	9,500
	23	dsl	905	Emsco GC-500	800	9,500
Gustavson Drlg Co Ltd	4	dsl	850	Natl 55	850	10,000
Pennant Drlg Co Ltd	1	dsl	1050	M-CSCO U-40	1000	10,000
Regent Drlg Co Ltd	8	dsl	750	Brwstr N-75	780	10,000
Waterton						
Commonwealth Drlg Co Ltd	1	dsl	1350	Natl 110	1500	14,000
Whitecourt						
Double-A-Drlg Co Ltd	12	dsl	800	Ideco H-525	530	9,000
Willesden Green						
Commonwealth Drlg Co Ltd	3	dsl	690	Natl 50	600	6,500
	13	dsl	630	Emsco GA-350	720	6,500
Gen Petroleums Drlg Co Ltd	17	dsl	1325	Natl 55	1050	10,000
Regent Drlg Co Ltd	7	dsl	1200	Natl 125	1500	15,000
Windfall						
Gen Petroleums Drlg Co Ltd	16	dsl	1100	Natl 55	1000	10,000
	18	dsl	1400	Natl 80-B	1400	13,000
Worsley						
Gen Petroleums Drlg Co Ltd	23	dsl	625	Natl 50-A	550	7,500
Regent Drlg Co Ltd	5	dsl	720	Brwstr N-7	520	8,000
BRITISH COLUMBIA						
Undesignated						
Canamerican Drlg Corp Ltd	*1	dsl	500	Natl T-32	335	6,500
Hi-Tower Drlg Co Ltd	5	dsl	350	Natl 50	400	5,500
	11	dsl	350	Crdwll 200	300	6,000
	13	dsl	350	Crdwll 200	300	6,000
Reading & Bates Drlg Co Ltd	5	dsl	750	Natl 50-A	750	9,000
	6	dsl	12000	Natl 80-B	12000	14,000
Alaska Highway						
Commonwealth Drlg Co Ltd	22	dsl	750	Natl 50	530	6,500
Beaton River						
Cascade Drlg Co Ltd	9	dsl	—	Natl T-32	—	5,500
Gen Petroleums Drlg Co Ltd	22	dsl	300	Natl T-32	275	5,500
Parker Drlg Co of Canada Ltd	8	dsl	500	Natl 50-A	700	7,500
Trinity Canadian Drlg Co	4	dsl	990	Natl 80-B	990	12,000
Boundary Lake						
Peter Bawden Drlg Ltd	3	dsl	278	Crdwll S	160	4,500
Ft. Nelson						
Brinkerhoff Drlg Co Ltd	14	dsl	370	Emsco GB-500	600	8,500
Cascade Drlg Co Ltd	2	dsl	1000	Natl 100	1000	12,000
	4	dsl	835	Natl 50-A	556	7,500
Commonwealth Drlg Co Ltd	15	dsl	800	Brwstr N-7	600	8,000
Cascade Drlg Co Ltd	18	dsl	933	Natl 100	933	12,000
	19	dsl	1645	Natl 100	975	12,000
Commonwealth Drlg Co Ltd	20	dsl	1270	Ideco 7-11	900	10,500
Trinity Canadian Drlg Co	7	dsl	875	Emsco GC-500	720	10,000
Ft. St. John						
Gen Petroleums Drlg Co Ltd	24	dsl	350	Natl T-32	275	5,500
Gustavson Drlg Co Ltd	5	dsl	420	Natl T-45	420	7,500
Trinity Canadian Drlg Co	1	dsl	995	Emsco GC-500	770	10,000
Hudson Bay						
Parker Drlg Co of Canada Ltd	4	dsl	800	"Oilwell" 76	1100	12,500
Jedney						
Peter Bawden Drlg Ltd	24	dsl	556	M-CSCO U-15	556	7,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Kotaho Lake						
Peter Bawden Drlg Ltd	19	dsl	556	Emsco GB-500	556	8,500
Brinkerhoff Drlg Co Ltd	20	dsl	370	Natl 50-A	450	8,500
Laprise Creek						
Brinkerhoff Drlg Co Ltd	23	dsl	250	Natl T-20	300	5,000
Commonwealth Drlg Co Ltd	24	dsl	520	Natl 50	600	6,000
Northern						
Canbridge Corp Ltd	*8	dsl	380	Crdwll Tr	380	6,000
	13	dsl	670	Emsco GA-500	670	9,000
	14	dsl	420	Emsco GB-350	420	7,500
Petitot River						
Cascade Drlg Co Ltd	11	dsl	556	Natl 50	556	6,500
Trutch						
Trinity Canadian Drlg Co	5	dsl	1250	Emsco A-800	1150	15,000
MANITOBA						
Virden						
Commonwealth Drlg Co Ltd	18	dsl	260	Ideco H-25D	300	4,500
Coultis Drlg Ltd	2	dsl	250	Wisn Torcair	250	4,000
	3	dsl	248	Wgnr Mrhse TD	2150	3,000
NORTHWEST TERRITORY						
Arrowhead River						
Peter Bawden Drlg Ltd	8	dsl	556	Natl 50-A	556	8,000
Colibeta						
Brinkerhoff Drlg Co Ltd	26	dsl	—	Emsco GB-350	425	7,000
Parker Drlg Co of Canada Ltd	10	dsl	500	Natl 50-A	700	7,500
Ft. Good Hope						
Big Indian Drlg Co Ltd	*5	gas	—	Mayhew	—	2,000/2⅛"
	9	gas	—	Mayhew	—	1,500/2⅛"

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Point Separation						
Peter Bawden Drlg Ltd	16	dsl	556	"Oilwell" 64B	556	7,500
SASKATCHEWAN						
Undesignated						
Canamerican Drlg Corp Ltd	*4	dsl	600	Natl T-20	275	5,000
	*5	dsl	500	Natl T-32	335	6,500
	*6	dsl	600	Natl T-12	275	4,000
	*7	dsl	600	Natl T-20	275	5,000
Hi-Tower Drlg Co Ltd	16	dsl	400	Crdwll 201	300	6,000
L and J Drlg Ltd	5	dsl	440	Crdwll "S"	300	4,500
Porter Drlg Ltd	*1	dsl	500	Natl T-32	360	6,000
	*2	dsl	720	Natl 50	720	8,000
Glen Ewen						
Gen Petroleums Drlg Co Ltd	9	dsl	400	Natl T-25	275	5,500
Midale						
Gen Petroleums Drlg Co Ltd	8	dsl	350	Natl T-25	275	5,000
Parkman						
Gen Petroleums Drlg Co Ltd	2	dsl	250	Natl T-20	275	4,800
Hunter Drlg Ltd	1	dsl	450	Crdwll	260	6,000
Regina						
Big Indian Drlg Co Ltd	1	gas	—	Mayhew	—	2,000/2⅛
YUKON						
Yukon						
Parker Drlg Co of Canada Ltd	1	dsl	800	"Oilwell" 76	1275	11,500

International Contractors

Big Chief Drlg Co Box 8837 Oklahoma City 14 Okla
Delta Overseas Drlg Co (Rome Italy) Box 2012 Tyler Tex
Deutsche Erdol-Aktiengesellschaft 180 Mittelweg Hamburg 13 Germany
Drilling & Exploration Ltd Van Wijngaerdenstraat 1 A Hague Holland
Drlg & Expl Co Inc Box 35366 Dallas 35 Tex
Graham-Michaelis Drlg Co 211 N Broadway Wichita 2 Kan
Helmerich & Payne Inc First Natl Bldg Tulsa Okla
Kerr-McGee Oil Industries Kerr-McGee Bldg Oklahoma City Okla
Laughlin-Porter Drlg Co Inc 212 Petroleum Life Bldg Midland Tex
Llano Drlg Co 301 V & J Tower Bldg Midland Tex
Nederlandse Boarmaatschappij N V Van Wijgaerdenstraat 1 A The Hague Holland
Offshore Co Box 1268 Baton Rouge La
Parker Drilling Co 418 Natl Bk of Tulsa Bldg Tulsa 3 Okla
Perforaciones Delta C A Apartado 9138 Caracas Venezuela (Box 2012 Tyler Tex)
Perforadora Central S A de C V Insurgentes Sur 114-212 Mexico 4 D F
Perforadora Latina SA Madrid 21-3° Mexico 4 DF
Perforadores Mexicanos de Petroleo SA Morelos 110 8th Floor Mexico DF
Santa Fe Drlg Co Box 310 Whittier Calif
C J Simpson Drlg Co P O Box 10345 Dallas 20 Texas
Societe Forex P O Box 28 PAU Basses Pyrenees France
Societe Languedocienne de Forages Petroliers 15 Rue Des Sablons Paris 16 France
The Southeastern Drlg Corp Room 1101 211 North Ervay Bldg Dallas Tex
Southland Drlg Co 435 Milam Bldg San Antonio Tex
Walters Drlg Co Inc 4114 McMillan Dallas 6 Tex

International Rig Section

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
ARGENTINA						
Kerr-McGee Oil Ind Inc	*CU 1	dsl	110	Wgnr-Mrhse E-15-38B	280	3,000
	*CU 2	dsl	110	Wgnr-Mrhse E-15-38B	280	3,000
	CU 3	dsl	110	Wgnr-Mrhse E-15-38B	280	3,000
	3	dsl	970	Natl 75	1000	11,500
	28	dsl	970	Natl 75	1000	11,500
	41	dsl	970	Natl 75	1000	11,500
	42	dsl	970	Natl 75	1000	11,500
	52	dsl	500	Emsco GC-350T	840	6,000
	53	dsl	500	Emsco GC-350T	840	6,600
Perforaciones Laughlin-Porter S A (Perlap)	2	gas	700	U-15	700	7,500
	5	dsl	800	Natl 100	1000	12,000
	8	gas	900	Natl 75	900	10,000
	*9	dsl	800	Ideco H-30	300	4,500
Southeastern Drlg Co	70	dsl	600	Ideco H-525	1040	8,500
	71	dsl	600	Ideco H-525	1040	8,500
	72	dsl	600	Ideco H-525	1040	8,500
	73	dsl	600	Ideco H-525	1040	8,500

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
	74	dsl	600	Ideco H-525	1040	8,500
	75	dsl	600	Ideco H-30	357	8,500
AUSTRALIA						
Delta Drlg Co	41	dsl	1300	Natl 130	1400	16,000
BOLIVIA						
Big Chief Drlg Co	29	dsl	1875	Emsco 1250	1815	16,000
	31	gas	1545	Emsco 800	1515	13,500
	37	gas	1875	Emsco 1250	1815	16,000
Kerr-McGee Oil Ind Inc	51	dsl	970	Natl 75	1000	11,500
Parker Drlg Co	1	gas	400	Emsco	350	7,000
BRAZIL						
Parker Drlg Co	62	gas	—	Natl 50	1000	9,000
BRITISH HONDURAS						
Kerr-McGee Oil Ind Inc	14	dsl	695	Natl 50	630	9,000
	50	dsl	1000	Natl 55	750	10,000
Offshore Co	58	dsl-elec	1250	Emsco A-1100E	2100	15,000
COLOMBIA						
Llano Drlg Co	8	dsl	800	Ideco H-30	300	4,500
COSTA RICA						
Drlg & Expl Co Inc	42	dsl	1800	"Oilwell" 96	2000	18,000
COTE D'IVOIRE						
Societe Languedocienne de Forages Petroliers	6	dsl	1200	Emsco 800	1900	13,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
CUBA						
C J Simpson Drlg Co	2C	dsl-gas	—	M-CSCO U-40	900	12,000
	3C	dsl-gas	—	Emsco D-450	700	7,000
	4	gas-btne	—	Natl T-20	275	5,000
DOMINICAN REPUBLIC						
Graham-Michaelis Drlg Co	2	dsl	500	M-CSCO U-15	500	7,000
FRANCE						
Societe FOREX	*—	dsl	375	Haniel & Lueg	125	—
	*F-2500/6	dsl	300	Failing	150	—
	*H-25	dsl	650	Ideco	250	—
	H-30/2	dsl	800	Ideco	250	4,500
	*H-30/3	dsl	—	Ideco	250	—
	H-40/3	dsl	800	Ideco	250	6,000
	55/1	dsl	1000	Natl	700	9,000
	H-525/1	dsl	850	Ideco	500	7,500
	S-7/11-1	dsl	1600	Ideco	1500	15,000
Societe Languedocienne de Forages Petroliers	*—	dsl	350	Massarenti	520	4,000
	*1	dsl	1000	Ideco H-525	520	8,500
	2	dsl	1000	Natl 100	840	11,000
	2	dsl	1200	Ideco 7-11	1900	13,000
	3	dsl	1130	Natl 50	520	8,000
	4	dsl	600	Emsco 250	750	7,000
	4	dsl	950	Natl 50	520	8,000
	5	dsl	850	Natl 50	800	8,000
	5	dsl	1300	Ideco 1350-S	1900	15,000
	7	dsl	1300	Ideco 7-11	1660	13,000
	*S-206	dsl	110	Crdwll	140	10,000
	SOG	dsl	1200	Ideco 7-11	1425	13,000
GABON						
Societe FOREX	H-40/1	dsl	750	Ideco	260	6,000
GULF OF PARIA						
Offshore Co	55	dsl-elec	1250	Natl 130-E	2400	20,000
HOLLAND						
Nederlandse Boormaatschappij N V	4	dsl	1200	Natl 75	900	10,000
IRAN						
Southeastern Drlg Co	50	dsl	1600	OW-96	1600	16,000
	51	dsl	1600	OW-96	1600	16,000
	54	dsl	2200	OW-96	1600	16,000
	55	dsl	1600	OW-96	1000	16,000
	57	dsl	2200	OW-96	1600	16,000
	Seacat 58	dsl	1600	OW-96	2200	16,000
IRAQ						
Drlg & Expl Co Inc	—	dsl	1125	Ideco H-525	550	5,000
	—	dsl	1375	Ideco H-525	550	5,000
	—	dsl	1000	Natl 100	1700	15,000
Drlg & Exploration Ltd	1	dsl	1000	Ideco 525	400	7,000
	2	dsl	1000	Ideco 525	400	7,000
ITALY						
Delta Overseas Drlg Co	4	dsl	900	Emsco 800	900	11,000
	3	dsl	500	Emsco GB-500	500	8,500
	2	dsl	260	Ideco H-30	300	4,500
	1	dsl	900	Emsco 500	600	7,000
JORDAN						
Parker Drlg Co	46	gas	—	Natl 75	700	10,000
KUWAIT						
Southeastern Drlg Co	12	dsl	2200	OW-96	1100	16,000
	52	dsl	400	Natl U-15	800	8,500
LIBYA						
Nederlandse Boormaatschappij N V	2	dsl	1200	Natl 80-B	1200	12,000
MADAGASCAR						
Societe Languedocienne de Forages Petroliers	7	dsl	750	Natl 100	1600	11,000
MEXICO						
Jett Drlg Co Inc	109	gas-gaso	1000	Brwstr N-7	800	9,500
Perforadora Central S A de C V	1	dsl	750	Emsco GC-500	500	10,000
	2	dsl	750	Natl Ideal-55	500	10,000
	3	dsl	750	Emsco G-500	500	10,000
	4	dsl	750	Emsco GC-500	600	10,000
Perforadora Latina, S A	6	dsl	975	Emsco G-500	500	7,500
	7	dsl	775	M-CSCO	350	5,000
	8	dsl	975	Emsco GB-500	500	7,500
Perforadores Mexicanos De Petroleo S A	1	gas	900	Ideco	900	—
	2	gas	900	Ideco	900	—
Walters Drlg Co Inc (Dallas)	11	gas	150	Mayhew 1000	150	600/2⅞"
NIGERIA						
Nederlandse Boomaatschappij N V	1	dsl	1200	Natl 80-B	1200	12,000
	3	dsl	1200	Natl 80-B	1200	12,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Perforadora Latina S A	9	dsl	975	Emsco GB-500	500	7,500
	10	dsl-elec	975	Natl 34-10	1000	12,000
	11	dsl-elec	975	Natl 23-10	1000	12,000
	12	dsl	1250	Emsco 750	1250	12,000
	13	gas	1200	Natl 80-B	1000	12,000
	14	gas	1050	Natl 100	950	12,000
Southland Drlg Co	*3	gas	925	Crdwll "O"	750	10,000
	*5	gas	925	Emsco 500	750	10,000
MOROCCO						
Societe FOREX	55/2	dsl	1000	Natl	700	9,000
	S-7/11-2	dsl	1100	Ideco	1350	11,500
NIGERIA						
Societe FOREX	H-40/2	dsl	750	Ideco	250	6,000
PERSIAN GULF						
Offshore Co	56	dsl-elec	2000	Natl U-3410-FE	2000	20,000
PORTUGUESE GUINEA						
Drlg & Expl Co Inc	40	dsl	700	Emsco GB-500	1050	7,500
SAHARA						
Societe FOREX	*—	dsl	—	Wgnr Mrhse	200	—
	—	dsl	2000	Emsco A-1500	100	17,000
	*160	dsl	375	Emsco	200	—
	*F-2500/1	dsl	150	Failing	150	—
	*F-2500/2	dsl	150	Failing	150	—
	*F-2500/3	dsl	150	Failing	150	—
	H-7/11	dsl	1200	Ideco	1200	10,000
	H-30/1	dsl	800	Ideco	250	4,500
	GB-250/1	dsl	500	Emsco	250	6,000
	GB-250/2	dsl	500	Emsco	250	6,000
	GB-250/3	dsl	500	Emsco	250	6,000
	H-525/2	dsl	750	Ideco	500	7,500
	S-7/11-3	dsl	1600	Ideco	1500	15,000
	PR-1050	dsl	1600	Ideco	1500	15,000
Societe Languedocienne de Forages Petroliers	2	dsl	1300	Emsco 800	1660	13,000
	3	dsl	1000	Emsco 800	1660	13,000
	5	dsl	1000	Emsco 800	1900	13,000
	3	dsl	1200	Ideco 7-11	1900	13,000
	4	dsl	1300	Ideco 7-11	1660	13,000
	6	dsl	1300	Ideco 7-11	1660	13,000
	N	dsl	1000	Ideco H-525	520	8,500
	SOG	dsl	1200	Ideco 7-11	1900	13,000
	6	dsl	1000	Natl 80-B	1900	13,000
	8	dsl	1000	Natl 110	1900	15,000
	9	dsl	1200	Natl 110	1760	15,000
	10	dsl	1000	Natl 50	1200	8,000
SENEGAL						
Societe FOREX	Natl 100	dsl	1300	Natl 100	800	11,500
SPAIN						
Societe Languedocienne de Forages Petroliers	1	dsl	1300	Natl 100	840	11,000
SYRIA						
Deutsche Erdol-Aktiengesellschaft	530	dsl	780	Wirth GH-500	870	9,000
VENEZUELA						
Helmerich & Payne Inc	61	dsl	—	Natl 125	—	—
	62	dsl	—	Natl 125	—	—
	63	stm	—	Natl 34-10	—	—
	64	stm	—	Natl 34-10	—	—
	65	dsl	—	Natl 50-A	—	—
	66	dsl	—	Natl 125	—	—
	67	dsl	—	Natl 110	—	—
	68	stm	—	Natl 34-10	—	—
Kerr-McGee Oil Ind Inc	V-1	dsl-elec	2000	Emsco A-800-E	1500	13,000
	V-2	dsl-elec	2000	Emsco A-1100-E	1500	16,000
Perforaciones Delta C A	1	dsl	260	Ideco H-40-D	400	6,500
	2	dsl	260	Ideco H-40-D	400	6,500
	3	dsl	260	Failing 2066	—	1,500
	4	dsl	260	Ideco H-40-D	400	6,500
	5	stm	1200	Emsco UBLS	1690	15,000
	*7	dsl	260	Ideco H-30-D	300	4,500
	9	dsl	1000	Emsco GB-800	900	12,000
	10	dsl	260	Crdwll D	450	7,500
	11	dsl	130	Natl T-12	120	2,500
	Bge 12	dsl	1560	Emsco J-1250	1250	15,000
	Bge 13	dsl	1040	Emsco J-1250	1250	15,000
	Bge 14	dsl-elec	2000	Emsco ECB	1200	15,000
	Bge 15	dsl-elec	2000	Emsco ECB	1200	15,000
	Bge 16	dsl-elec	2000	Emsco ECB	1200	15,000
	17	dsl	200	Crdwll R	250	4,500
	18	dsl	200	Crdwll R	250	4,500
	19	dsl	260	Crdwll TR	250	6,000
	20	dsl	260	Crdwll TR	250	6,000
	21	dsl	260	Crdwll TR	250	6,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
	22	dsl	520	Natl 80-B	800	10,000
	23	dsl	520	Natl 100	900	12,000
Santa Fe Drlg Co	23	dsl	300	Ideco H-40	300	6,000
WESTERN GERMANY						
Deutche Erdol-Aktiengesellschaft	118	dsl	780	Natl 50-A	870	9,000
	100	dsl	200	Wirth 904	240	4,000
	130	dsl	780	Wirth GH-500	870	9,000
	145	dsl	1790	Natl 80-B	1700	14,000
	230	dsl	780	Wirth GH-500	870	9,000
	245	dsl	1790	Natl 130	1700	20,000
	330	dsl	780	Natl 50-A	870	9,000
	430	dsl	780	Wirth GH-500	870	9,000
	630	dsl	780	Wirth GH-500	870	9,000
	830	dsl	960	Natl 80-B	1275	12,000
	L1	dsl	200	Wirth 504	240	2,500
	LFB-6	dsl	80	Failing 2500	90	2,500

Offshore Rig Locator

DRILLING CONTRACTORS

Blue Water Drilling Corp 1001 Carondelet Bldg New Orleans La

Caldrill Offshore Inc 3400 Loma Vista Rd Ventura Calif
Circle Drilling Co 620 Pioneer Bldg Lake Charles La
Coral Co Inc 6100 Camp Bowie Blvd Ft Worth Tex

Delta Marine Drlg Co Box 2012 Tyler Tex
Dixilyn Drilling Corp Box 3427 Odessa Tex

Global Marine Expl Co 650 S Grand Ave Los Angeles 17 Calif

Kerr-McGee Oil Industries Inc Kerr-McGee Bldg Oklahoma City Okla

Louisiana-Delta Offshore Corp 211 Maritime Bldg New Orleans 12 La

Mobile Offshore Co 743 San Jacinto Bldg Houston 2 Tex

Nickles Drlg Co 518 First Natl Bank Bldg Houston 2 Tex

Ocean Drilling & Production Offshore Co 300 Caribe Bldg New Orleans La
Box 1268 Baton Rouge La

Penrod Drlg Co 1320 Mercantile Security Bldg Dallas Tex

Reading & Bates Offshore Co 610 Saratoga Bldg New Orleans La
Rimrock-Tidelands Inc P O Box 896 New Orleans La

Salt Dome Production Co 737 Texas Natl Bank Bldg Houston 2 Tex

Sea Drlg Corp 809 Whitney Bldg New Orleans La
The Southeastern Drlg Corp 901 Employers Ins Bldg Dallas 2 Tex

Tideland Drlg Co 215 Shell Bldg New Orleans La

Zapata Off-Shore Co 1701 Houston Club Bldg Houston Tex

CALIFORNIA

Contractor's Name	Rig, barge Name or No.	Type rig Power	Total HP all main mud pumps	Drwwks Make & Model	Total HP available to Drwwks	Rated depth with 4½" pipe	Max. water depth capacity ft	Location
Caldrill Inc	D	dsl	1700	OWS 96	1200	18,000	—	Santa Barbara
	E	dsl elec	1200	OWS 860E	1000	14,000	—	Santa Barbara
Global Marine Expl Co	Cuss 1 Floating Barge	dsl	1750	Natl 80-B	1750	12,000	—	Santa Barbara
	Sm-1 Floating Barge	dsl	420	Hopper GTA	420	3,000	—	Santa Barbara

FLORIDA

Zapata Off-Shore Co	Nola III	dsl	1200	J-1250 Emsco	1200	15,000	—	Monroe

GULF OF MEXICO

Dixilyn Drlg Corp	No 8 "Julie Ann" Mobile Drlg Bge	dsl	2490	Natl 1625 DE	2490	25,000	105	
Tidelands Drlg Co	Mr Gus No 2 Mobile Drlg Bge	dsl elec	3600	Natl 160E	1800	20,000	150	

LOUISIANA

Blue Water Drlg Corp	"Blue Water No 1" Mobile Drlg Barge	dsl elec	2700	Emsco EDES	2600	20,000	67	Ship Shoal Block 139
Circle Drlg Co Inc	Bge 6	dsl elec	2300	Ideco E-2500	2750	20,000	—	—
Coral Drlg Co	#1-mobile	dsl elec	3000	Brwatr N-12	3000	20,000	70	Cameron Parish
Delta Marine Drlg Co	Joseph Zeppa	dsl elec	1600	Emsco JB-1250	1600	15,000	—	—
	Chris Zeppa No 2	dsl elec	2000	Ideco Big gnt	1200	15,000	34	Eugene Island
Kerr-McGee Oil Ind Inc	39	dsl	1500	"Oilwell" 96	1560	15,000	—	Morgan City
	40	dsl	2000	Emsco J-1600	2080	15,000	18	Ship Shoal Area
	43	dsl	1880	Emsco J-1000	1500	15,000	—	Morgan City
	44	dsl	2000	Ideco 1350-S	1700	18,000	40	—
	45	dsl	1500	Natl 125	1560	15,000	35	Vermilion Area
	46	dsl elec	2000	Emsco EDA	1250	20,000	70	W. Cameron
	47	dsl elec	2000	Emsco	1250	20,000	70	S. Timbalier
	48	dsl elec	2000	Emsco EDA	1250	20,000	—	Ship Shoal Area
Louisiana-Delta Offshore Corp	1	dsl	800	M-CSCO U-20	1000	14,000	—	—
	2	dsl elec	1400	M-CSCO U-1220	1200	20,000	—	—

Contractor's Name	Rig, barge Name or No.	Type rig Power	Total HP all main mud pumps	Drwwks Make & Model	Total HP available to Drwwks	Rated depth with 4½" pipe	Max. water depth capacity ft	Location
	3	dsl elec	2000	M-CSCO U-1220	1200	20,000	—	Grand Isle
Movible Offshore Co	Movible No 2 Mobile Drlg Bge	dsl elec	2000	Natl 1625	2500	25,000	70	South Pass
	Movible No 3	dsl elec	1700	Emsco EDA	1600	20,000	40	West Cameron
	4	dsl elec	1450	M-CSCO U-914	1400	16,000	200	—
Nicklos Drlg Co	21 Mobile Drlg Bge	dsl eng	2250	Natl 130	2250	20,000	8	Vermilion Parish
	22 Tender	dsl eng	—	Natl 125	1400	17,000	50	Plaquemines Parish
Ocean Drlg & Expl Co	John Hayward	dsl elec	—	Emsco ECA	—	15,000	30	East Cameron
	El Dorado	dsl elec	—	Emsco EDES	—	15,000	70	St. Mary
	Margaret	dsl elec	—	Emsco EDES	—	15,000	65	—
	Mr Charlie	dsl elec	—	Emsco	—	15,000	40	Terrebonne Parish
	St Louis	dsl elec	—	Emsco ECA	—	15,000	30	Eugene Island
Offshore Co	52	dsl	2000	Natl 130	2000	20,000	—	Eugene Isle
	53	dsl elec	1800	Natl 130E	1800	20,000	—	Cameron
	54	dsl elec	1250	Natl 130E	2400	20,000	—	Vermilion
Penrod Drlg Co	50	dsl	2500	Emsco EDES	1800	20,000	60	Lafourche
	51	dsl	2000	Emsco EDES	1800	20,000	60	Lafourche
Reading & Bates Expl Co	Mr" Louie" Mobile Drlg Bge	dsl elec	2000	M-CSCO U-1220	2000	20,000	120	—
Reading & Bates Offshore Drlg Co	Geo M Reading Tender	dsl eng	3000	Natl 130	2000	18,000	—	South Marsh Island
Reading & Bates Expl Co	G L Temple Tender	dsl	2700	"Oilwell" 96	2700	18,000	—	Eugene Island
Rimrock-Tidelands Inc	*"Rimtide" Mobile Drlg Bge	dsl	2000	Emsco A-1500	1500	20,000	36	—
	Union Prod Co Drill Bge A Mobile Drlg Bge	dsl elec	1250	Ideco E-2500	1600	25,000	70	Ship Shoal Area
Salt Dome Prod Co	14 Tender	dsl	—	Natl 55	850	10,000	—	Lafourche
Sea Drlg Corp	*2	dsl elec	1800	Natl	1800	18,000	30	Cameron
	*3	dsl elec	1800	Emsco	1800	18,000	30	—
Southeastern Drlg Co	21	—	2200	"Oilwell" 96	2200	16,000	—	—
	22	dsl elec	2200	Natl 8.5 FE 34	2200	16,000	25	Terrebonne Parish
Zapata Off-shore Co	Scorpion	dsl	2000	"Oilwell" 96	2000	18,000	85	Cameron
NEW YORK								
Global Marine Expl Co	Submarex Floating Vessel	dsl	600	Howard Turner	150	—	—	Buffalo
TEXAS								
Penrod Drlg Co	52	dsl	2000	Emsco EDES	1800	20,000	100	Freeport
Zapata Off-shore Co	Vinagaroon Mobile	dsl	2400	"Oilwell" 96	2400	18,000	110	Galveston
TRINIDAD, W. I.								
Zapata Off-shore Co	Nola I	dsl	2000	130 Natl	2000	15,000	—	—
PERSIAN GULF								
Reading & Bates Offshore Drlg Co	O E Thornton Mobile	dsl	2400	Natl 130	1300	16,000	125	—
	J W Bates Tender	dsl	3000	Natl 130	2000	18,000	—	—

U. S. Cable Tool Drilling Contractors

A

Aikins Drlg Co Box 545 Shelby Mont
Allen Drlg Co 4410 Venable Ave Charleston 4 W Va
Angelus Drlg Co Box 1029 San Angelo Tex
Arrowood Roy Box 338 Cross Plains 2 Tex

B

Barker C H Box 91 Toronto Kans
Bar-Lee Drlg Co Box 7264 Tulsa Okla
Barry Well Drlg Co West Star Rt Fallon Nev
Beck K L 3826 Randolph Blvd San Antonio Tex
Bell & Gault Drlg Co 408 John R St Clare Mich
Bennett and Roberts Drlg Russell State Bank Bldg Russell Kans
Berentz Drlg Co Box 22 Eureka Kans
Bernhardt Drlg Co 2469 Grand River Detroit 1 Mich
Boyd Tom Drlg Co 102 S 2nd St Artesia N M

C

Canton Oil & Gas Co 626 Renkert Bldg 306 N Market Ave Canton 2 Ohio
Carter Drlg Co 1640 W 34th St N Wichita Kans
Crouch Louis Box 687 Lockhart Tex
Cummins Drlg Co Altamont Ill

D

Dillier W L Box 205 Casey Ill

E

Eatmon Drlg Co Box 535 Kimball Neb
Ensminger Drlg Co Box 45 Chanute Kans

F

Fairman Drlg Co Hammersley Fork Pa
4-J Drlg & Well Serv Co Box 471 Drumright Okla

G

Gladson Willard & Odstrcil Bros Drlg Co 2705 W 35th St Snyder Tex
Gulf Coast Western Oil Co 1816 Republic Bldg Okla City Okla

H

Hatcher H F & Son Drlg Co Box 447 Smackover Ark
Highland Oil Co Inc Box 263 Jasper Ind

Hipp Chas E Box 26 Graham Tex
Holdeman Oil & Minerals Inc 812 N W W White Rd San Antonio Tex
Houchins Drlg Co Box 388 Mt Carmel Ill

J

Jetmar Well Serv Box 736 Great Bend Kans
Jones Buck Drlg Co Box 1085 McCamey Tex
Jones Kenneth E Producer 528 S 94th 9th Ave Tulsa Okla
Jones Bros Oil Co Sedan Kans

K

Kersey & Co Box 305 Artesia N M
Kirby Oil Ind Inc 5107 Center St Omaha 6 Neb
Knox Earl Drlg Co Box 125 Coweta Okla
Krumme Oil Co Box 749 Bristow Okla

L

Ladd Ralph G Box 5 Haskell Okla
Lawrence J W Box 942 Conrad Mont
Lindsay Drlg Co 1305 S Highland Chanute Kans
Lininger H J Box 37 Upper Sandusky O
Lin-Mour Drlg Co 1112 Oil & Gas Bldg Wichita Falls Tex
Lohmann-Johnson Drlg Co Inc 320 Indiana Bk Bldg Evansville Ind

Mc

McCabe Drlg Co Box 87 Cleveland Okla

M

Morgan Dave Drlg Co Box 820 Blackwell Okla

O

Oien Oil Corp Box 2235 Cut Bank Mont

P

Payne Bros Drlg Co 611-½ 12th St Box 15 Lawrenceville Ill
Peters Drlg Co American State Bk Bldg Great Bend Kans
Pollard C C & Son Box 65 Ft Stockton Tex
Prairie Drlg Co Box 2068 Casper Wyo
Prairie Oilfield Service Inc P O Box 97 Great Bend Kans

S

Sage Drlg Co Inc 800 Bitting Bldg Wichita 2 Kans
Shields Oil Producers Inc Box 709 Shields Bldg Russell Kans
Shulman Bros Box 191 Vandalia Ill
Signal Oilfield Serv Inc 415 Petr Club Bldg Denver Colo
Simons H H Co 416 E 9th St Colorado City Tex
Slape Don Drlg Co Box 432 Olney Ill
Smallwood Drlg Co Box 9365 Dallas Tex
Smith James Drlg Contr Box 33 Mertzon Tex
Smith Ray Drlg Co 305 Simons Bldg Dallas Tex
Story Jack L Box 1073 Dallas Tex
Strotman C W Drlg Co 620 S 30th St Mattoon Ill
Swindler H L Box 1247 Muskogee Okla

T

Temple Drlg Co Inc 320 Indiana Bk Bldg Evansville Ind
TOCK Drlg Co 617 Union National Bldg Wichita Kans
Troup & Suttles Inc Box 551 Holdenville Okla

V

A L & J N Varner 550 E N 21 St Abilene Tex
Virginia Drlg Co Inc 712 Brown Bldg Wichita 2 Kans

W

Wagner J H Drlg Co Box 751 Eldorado Kans
West Art Drlg Co 205 O'Michael Bldg Odessa Tex
Wright Drlg Co Box 348 Great Bend Kans

Y

Young W J 1511 Thompson Bldg Tulsa Okla

U. S. Contract CABLE TOOL Drilling Rigs

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Rated Drlg. Depth-Ft.	Rig Make & Model
		ARKANSAS			
Union County					
H F Hatcher & Son	1	gas-gaso	150	5000	Crdwll K
		ILLINOIS			
Clark County					
W L Dillier Inc	1	gas	65	1500	B Erie 60-L
Clay County					
Shulman Bros	2	gas-gaso	—	4000	Crdwll H
Don Slape Drlg Co	1	btne	—	—	Crdwll K
C W Strotman Drlg Co	3	gas	145	3600	Crdwll H
Effingham County					
Cummins Drlg Co	C-1	gas-gaso	65	1500	B Erie 24-L
Fayette County					
Cummins Drlg Co	C-2	gas-gaso	65	1500	B Erie 24-L
	C-3	gas-gaso	65	1500	B Erie 60-L
	C-4	gas-gaso	65	1500	B Erie 60-L
	C-5	gas-gaso	78	2500	B Erie 28-L
	C-6	gas-gaso	78	2500	B Erie 28-L
	C-7	gas-gaso	45	1000	B Erie 22-W
Franklin County					
C W Strotman Drlg Co	4	gas	175	3500	Crdwll K
Lawrence County					
Payne Brothers	2	dsl	—	3500	B Erie 36-L
	3	dsl	—	3500	B Erie 36-L
Wabash County					
Payne Brothers	1	dsl	—	3500	B Erie 36-L
C W Strotman Drlg Co	1	gas	145	3600	Crdwll H
White County					
Lohmann-Johnson Drlg Co Inc	2	btne	—	4500	Crdwll
Shulman Bros	1	gas-gaso	—	4000	Crdwll H
		INDIANA			
Gibson County					
Highland Oil Co Inc	1	dsl	—	2000	B Erie 24-L
	2	dsl	—	3000	B Erie 28-L
C W Strotman Drlg Co	2	gas	175	3500	B Erie 36-L
Spencer County					
Temple Drlg Co Inc	1	btne	1800	1800	B Erie 24-L
		IOWA			
Dallas County					
Kirby Oil Ind Inc	—	gas-gaso	145	—	B Erie 28-L
	—	gas-gaso	145	—	Crdwll RL
		KANSAS			
Allen County					
Lindsay Drlg Co	2	dsl	104	3200	Star Spdr 43

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Rated Drlg. Depth-Ft.	Rig Make & Model
Barber County					
Wright Drlg Co	1	btne	GK-145	8000	Crdwll 423
	3	btne	GK-145	8000	Crdwll 667
Barton County					
Bennett & Roberts Drlg Inc	2	dsl	250	6000	Emsco GA-250
Peters Drlg Co	241	Cummins	300	6500	Crdwll KL
Signal Oilfield Serv	1	prop	150	6000	Crdwll RL
	7	prop	135	5000	Wlkr-Nr C-34
	9	dsl	145	6000	Crdwll RL
Butler County					
J H Wagner Drlg Co	2	gas-LPG	145	3500	B Erie 36-L
	3	gas-LPG	145	3500	B Erie 36-L
Chautauqua County					
Jones Bros Oil Co	—	prop	140	1650	Ft Wrth Spdr
Comanche County					
Carter Drlg Co Inc	4	btne	145	11,000	Crdwll RL
Ellis County					
Sage Drlg Co Inc	1	prop	120	4500	B Erie
Finney County					
TOCK Drlg Co	2	dsl	145	7500	Crdwll RL
Graham County					
Prairie Oilfield Serv Inc	1	LPG	150	10,000	Crdwll "RL"
Greenwood County					
C H Barker	1	gaso	145	3000	Wlkr-Nr 32
Berentz Drlg Co	2	dsl	165	3500	B Erie 36-L
	3	prop	140	3500	B Erie 36-L
Harvey County					
Wright Drlg Co	4	btne	GK 145	8000	Crdwll 683
Marion County					
Berentz Drlg Co	4	prop	145	3500	B Erie 36-L
Carter Drlg Co	1	btne	140	6000	Wlkr-Nr S-43
	2	btne	140	4000	Wlkr-Nr
Meade County					
Bennett & Roberts Drlg Co	3	dsl	500	8000	Emsco GA-500
Morton County					
Bennett & Roberts Drlg Co	1	dsl	250	6000	Emsco GB-250
Neosho County					
Ensminger Drlg Co	1	dsl	55	1500	Star Drlg Co
Lindsay Drlg Co	3	prop	90	1500	B Erie 24-L Spdr
Rooks County					
Peters Drlg Co	674	Cummins	200	6500	Crdwll RL GMD
Shields Oil Prod Inc	3	dsl	—	8000	B Erie 48-L
TOCK Drlg Co	4	dsl	—	5000	Crdwll

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Rated Drlg. Depth-Ft.	Rig Make & Model
Russell County					
Shields Oil Prod Inc	2	dsl	—	8000	Crdwll
Stafford County					
Jetmar Well Serv	1	prop	—	—	Cooper E-563
Virginia Drlg Co Inc	1	btne	150	4000	M-CSCO
Wright Drlg Co	2	dsl	Buda 844	8000	Crdwll 528
Sumner County					
Peters Drlg Co	673	Waukesha	145	6500	Crdwll RL GMD
Wilson County					
Lindsay Drlg Co	1	dsl	90	3200	Star Spdr 43
		KENTUCKY			
Bell County					
Graham-Michaelis Drlg Co	3	dsl	150	3500	B Erie 36
		MICHIGAN			
Arenac County					
Bernhardt Drlg Co	1	btne	—	5000	B Erie 36-L
Jackson County					
Bell & Gault Drlg Co	1	gas-btne	145	6000	Wlkr-Nr S-33
	3	gas-btne	200	7000	Wlkr-Nr S-46A
Lenawee County					
Bell & Gault Drlg Co	2	gas-btne	145	6000	Wlkr-Nr S-33
Macomb County					
Bernhardt Drlg Co	2	dsl-gas	—	6000	B Erie 36-L
		MONTANA			
Ponderoa County					
Aikins Drlg Co	2	gas	225	7500	Bucyrus 48-L
Teton County					
J W Lawrence	1	gas-gaso	125	3500	Natl
	2	gas-gaso	175	5000	B Erie
Toole County					
Aikins Drlg Co	1	gas	140	3500	Bucyrus 36-L
Oien Oil Corp	1	dsl	150	3000	B Erie 36-L
	2	gas-LPG	150	3000	B Erie 36-L
		NEBRASKA			
Banner County					
Eatmon Drlg Co	1	prop	—	—	Crdwll RL
Cheyenne County					
Eatmon Drlg Co	*2	prop	—	—	Crdwll RL
	*3	prop	—	—	Wlkr-Nr
		NEVADA			
Churchill County					
Barry Well Drlg	?	gaso	35	500	Custom Spdr
		NEW MEXICO			
Eddy County					
Tom Boyd Drlg Co Inc	1	btne	145	4500	B Erie 36-L
	2	btne	145	5000	Wich 61
Kersey & Co	3	gas-gaso	120	4000	Wich Spdr 61
	4	gas-gaso	120	4000	Natl 3
	1	gas-gaso	185	5000	Natl 3
	2	gas-gaso	120	3000	Wich Spdr 55
Fred Pool Drlg Co	—	—	4000	—	Ft Worth Spdr F37
	—	—	4500	—	Ft Worth Spdr J37
Lea County					
Tom Boyd Drlg Co Inc	3	btne	145	5000	Wich 61
Art West Drlg Co	3	gas	145	—	Crdwll KL
		OHIO			
Muskingum County					
Canton Oil & Gas Co	S-3	gas-gaso-prop	140	4500	B Erie 36-L
Portage County					
Canton Oil and Gas Co	S-7	dsl	175	5500	B Erie 36-L
Stark County					
Canton Oil & Gas Co	S-4	gas-gaso-prop	140	4500	Wlkr-Nr S-33
	S-5	gas-gaso-prop	140	4500	Wlkr-Nr S-33
	S-6	gas-gaso-prop	140	4500	B Erie 36-L
Wyandot County					
H J Lininger	1	gas-gaso	65	2500	Cyclone
		OKLAHOMA			
Creek County					
4-J Drlg & Well Serv	1	gaso	145	4000	B Erie 36-L
	2	gaso	135	4000	Wlkr-Nr 25-A
Krumme Oil Co	1	LPG	—	—	B Erie 36-L
	2	LPG	—	—	B Erie 36-L
W J Young	1	LPG	100	4000	Natl 2
	2	LPG	100	4000	Natl 2
Kay County					
Dave Morgan Drlg Co	—	LPG-gas	145	—	Crdwll RL
Muskogee County					
Earl Knox Drlg Co	28-L	LPG	90	2500	B Erie 28-L
Ralph G Ladd	1	gas-gaso	65	1750	Star Spdr-K
Swindler Oil Corp	1	gas	150	3500	Wlkr-Nr 33-S
	2	gas	150	2000	B Erie 28-L
Osage County					
McCabe Drlg Co	1	btne	—	3500	B Erie 36-L
W J Young	3	LPG	100	4000	Natl 3
Seminole County					
Gulf Coast Western Oil Co	1	btne-gas	145	5000	Wlkr-Nr C-34
Troup & Suttles Inc	1	gas-gaso	145	6000	Wlkr-Nr 33
Texas County					
TOCK Drlg Co	1	dsl	145	7500	Crdwll RL
	3	prop	145	8000	Wlkr-Nr C-34
Tulsa County					
Bar-Lee Drlg Co	1	LPG	120	3000	Wlkr-Nr 532
Kenneth Jones Drlg Co	1	gas	300	2500	Bucyrus 28-L
		PENNSYLVANIA			
Clearfield County					
Fairman Drlg Co	1	dsl	225	7500	B Erie Spdr 48-L
	2	dsl	225	7500	B Erie Spdr 48-L
	3	gas	225	7500	B Erie Spdr 48-L
	4	gas	225	7500	B Erie Spdr 48-L
	5	dsl	170	5000	B Erie Spdr 36-L
		TEXAS			
(Undesignated)					
Art West Drlg Co	7	gas	145	—	Crdwll RL
Archer County					
Chas E Hipp Company	12	btne	145	4000	B Erie 36-L
	14	btne	145	4000	B Erie 36-L
Baylor County					
Lin-Mour Drlg Co	3	btne	100	5000	Wlkr-Nr C-33
Bexar County					
Holdeman Oil & Minerals Inc	1	gaso	150	3000	Angelo
	2	gaso	90	1500	Alamo Iron W
Callahan County					
Roy Arrowood	2	btne	60	1500	—
A L & J N Varner	1	gaso	50	1000	B Erie 22-W
Clay County					
Jack L Story	1	gas	290	500	Wisn Mogul
Cooke County					
Chas E Hipp Co	11	btne	225	6000	B Erie 48-L
	15	btne	145	4000	B Erie 36-L
	16	btne	145	4000	B Erie 36-L
Ector County					
Ray Smith Drlg Co	32	gas-LPG	145	3500	Wlkr-Nr S-32
	33	gas-LPG	145	4500	Wlkr-Nr S-33
	43	gas-LPG	145	4000	Wlkr-Nr S-43
Art West Drlg Co	5	gas	185	—	Crdwll RL
	6	gas	145	—	Crdwll RL
	9	gas	185	—	Wisn Giant
	10	dsl	125	—	Crdwll RL
Gray County					
Murphy & McKernan	1	gas-gaso	145	5500	B Erie 36-L
	2	gas-gaso	145	5500	B Erie 36-L
Irion County					
James Smith Drlg Cont	1	btne	145	3000	B Erie 36-L
	2	btne	76	1500	B Erie 24-L
Jeff Davis County					
C C Pollard & Son	1	gas	150	4000	WCH 61 Spdr
	2	dsl	150	6000	WCH 66 Spdr
Midland County					
Chas E Hipp Co	17	btne	225	6000	B Erie 48-L
Mitchell County					
Willard Gladson & Odstrcil Bros Drlg Co	2	btne	—	5500	B Erie 36-L
	3	btne	—	4200	B Erie 28-L
H H Simons Co	1	btne	160	6200	Ft Wrth Spec
Pecos County					
Louis Crouch	1	btne	225	3000	B Erie 36
Buck Jones Drlg Co	2	btne	100	2500	Wlkr-Nr 32
Palo Pinto County					
Oney Drlg Co	3	LPG	222	5500	Wich 66
Scurry County					
Willard Gladson & Odstrcil Bros Drlg Co	1	btne	—	5500	B Erie 36-L
Shackelford County					
A L Varner	2	btne	120	1500	Failing Mud & Air
Tom Green County					
Angelus Drlg Co	1	btne	100	2000	Super H Ft Wrth
Upton County					
Buck Jones Drlg Co	1	btne	140	4000	Wlkr-Nr 33
	3	btne	150	5000	Natl 3
Ward County					
Art West Drlg Co	8	gas	145	—	Crdwll RL
Wichita County					
Lin-Mour Drlg Co	2	gas	125	—	Wlkr-Nr C-34
Young County					
Oney Drlg Co	2	LPG	145	4000	Wich 61

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Rated Drlg. Depth-Ft.	Rig Make & Model
WEST VIRGINIA					
Doddridge County					
Houchins Drlg Co	1	gaso	185	—	Crdwll "K"
Mingo County					
Allen Drlg Co	3	gas	128	4000	Natl Mch No. 2
WYOMING					
Westen County					
Prairie Drlg Co	1	btne or nat	290	10,000	Crdwll RL-705

Canadian CABLE TOOL

Culver Drlg Co Ltd Box 92 Dunnville Ontario Canada

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Rated Drlg. Depth-Ft.	Rig Make & Model
Ontario Province					
Culver Drlg Co Ltd	1	dsl-b.m.c.	80	3000	B Erie 28-L
	2	dsl-b.m.c.	80	1500	B Erie 24-L
	3	dsl-b.m.c.	80	1500	B Erie 24-L

U. S. Well Servicing Contractors

A

Acme Well Serv Co Box 1331 Abilene Tex
Adams Prod Serv 2 Monte Vista Dr Bakersfield Calif
Albright Well Serv Co Box 1192 Hobbs N M
Anderson Oil Well Serv Box 304 McPherson Kans
Atlas Well Serv Inc Box 387 Ft Morgan Colo

B

B & H Well Serv Box 1475 Coahoma Tex
Baggett Drlg Co 4305 Univ Ave Wichita Falls Tex
Geo H. Baldwin Oil Well Serv Box 307 Bridgeport Ill
Barnard Well Serv Box 617 Madison Kan
Barnes Bros Well Serv Box 232 Gainesville Tex
Basin Well Serv Inc 2411 Rankin Hwy Midland Tex
Bateman & Whitsitt Inc Box 1956 Hobbs N M
Bayou Well Works Inc Box 78 New Iberia La
Beall Well Serv Co Box 20044 Houston 25 Tex
Beckman Inc Box 1524 Muskogee Okla
Berry Dick Well Serv Box 732 Great Bend Kans
Best Well Serv Box 338 Fillmore Calif
Billings M E Well Serv Inc 928 E 15th St Casper Wyo
J W (Johnny) Birdwell Well Serv Box 201 Kamay Tex
Bivin & Smoot Drlg Co Box 147 Overton Tex
Black Gold Well Serv Box 1427 OCS Lafayette La
Brake Raymond K Well Serv Box 285 Centralia Ill
C H Brockett Inc Box 1005 Midland Tex
Browning Well Serv Inc Box 163 McLeansboro Ill
Busby Well Serv Box 93 McLeansboro Ill

C

California Prod Serv Inc 3252 Cherry Ave Long Beach 7 Calif
Capshaw Well Serv Co Box 1915 Casper Wyo
Carlton Well Serv Box 91 South Houston Tex
Carpenter R L Box 452 Sapulpa Okla
Carter Well Serv Box 178 Pettus Tex
Chambless-Rosen Drlg Co Box 4294 Oklahoma City 9 Okla
Chase Well Serv Inc Box 325 Chase Kans
Chris Well Servicing Co Ltd 712 Commerce Exchange Bldg Oklahoma City Okla
Christian Sarratt & Wallace Ltd 712 Commerce Exchange Bldg Oklahoma City Okla
Clark Well Serv Co Box 4752 Oklahoma City 9 Okla
Clarke Oil Well Serv Co Box 2315 Hobbs N M
Clarke & Dennis Well Serv Inc Box 5 Medicine Lodge Kans
Clinch Drlg Co Box 27 Hazlehurst Miss
Colo Well Serv Inc Box 122 Rangely Colo
Comanche Well Serv Box 98 Comanche Okla
Copeland & Fuller Well Serv Box 237 Kenedy Tex
Craig Well Serv Box 1796 Hobbs N M
Cramer Well Serv 503 N Creek Drumright Okla
Crews Well Serv Box 756 Alice Tex
Jess P Cross Drlg Contr 1216 Texas St Graham Tex
Crusader Drlg & Serv Inc Box 851 Springhill La

D

D & J Serv Inc Box 1477 Levelland Tex
D & L Drlg & Serv Box 121 Perryton Tex
D & S Well Serv Co Box 102 Cody Wyo
Dapsco Inc Box 918 Laurel Miss
Devonian Well Serv Box 2821 Odessa Tex
Dickinson R D & Richardson H F DBA Well Service Co Rt 2 Longview Tex
Dicks Well Serv Co Rt 2 Powell Wyo
Doe Robert B—Oilfield Serv Rt 1—19030 James Rd Bakersfield Calif
Dollins Bro's Oil Well Serv Co Rt 2 Box 69 Breckenridge Tex
Douglas V Downing Well Serv Box 206 Devine Tex
Drilling & Production Co 2907 L St Bakersfield Calif
Dyer Drlg Co Box 338 Casper Wyo

E

Eatmon Drlg Co Box 535 Kimball Neb
Eichler Well Service Box 515 Jacksboro Tex
Emerson Well Service & Gen Contrg Box 228 Sulphur Springs Tex

F

Finley Oilwell Serv Inc Box 7296 Long Beach Calif
Fish Oil Well Serv Box 809 Beeville Tex
Flint Rig Co Box 342 Kimball Neb

G

Galloway Bros Continental Bk Bldg Ft Worth Tex
Graham J P Box 1307 Bay City Tex
Gulf Tide Drlg Co 450 Saratoga Bldg New Orleans La
Gwaltney Henry Drlg Co Box 289 Washington Ind

H

H & W Oil Well Service Box 435 Roundup Montana
Ham Carl S Inc Box 1058 Andrews Tex
Hamm Dick Drlg Co Box 575 Grandfalls Tex
John Haseman Inc 419 Wilson Bldg Corpus Christi Tex
Hayden & Griffith Oil Well Serv Co 304 Calif Bldg Denver 2 Colo
Hillier J E Box 67 Pleasanton Tex
Holston Well Serv Inc Box 651 Jennings La
Holt Ivan Well Serv Box 401 Russell Kans

I

Ideal Casing Co Box 746 Wink Tex
Index Drlg Co Inc Box 928 Laurel Miss

J

J & M Well Serv Box 445 Mission Tex
Jackson Neal & Sons Star Rt East Artesia N M
Jetmar Well Serv Box 736 Great Bend Kansas
Johnson F M Well Serv Box 613 Olney Tex

K

Kent Well Serv Co Drawer 470 Eldorado Kans
Kent Oil Field Serv Inc Box 749 Eldorado Kans

L

L & W Well Serv MRH Box 120 Sulphur La
Lafourche Workover & Drlg Co Inc Box 8 Galliano La
Lininger Oil & Gas Co Box 37 Upper Sandusky Ohio
Locke Well Service Box 312 Royalty Tex
Lohmann Oil Well Serv Inc Box 1504 Farmington N M

Mc

McAdams J F Box 1716 Hobbs N M
McAlister Well Serv Box 2214 Wichita Falls Tex
McDaniel Well Serv Box 456 Seminole Okla
McDonald Well Serv Co Box 2062 Abilene Tex

M

Mac Drlg Co Box 2972 Houston Tex
Macrate Prod Co 3341 Cherry Ave Long Beach 7 Calif
Marine Well Serv Co Box 1 Marine Ill
Martin Lubie Drlg Co 2052 Harvard St Houston Tex
Mercer Jack Well Serv Box 509 Nocona Tex
Moore Petroleum Serv Box 205 Missouri City Tex
Moore Prod Serv 1843 East O St Wilmington Cal
Mumy Well Serv 7941 Patterson Rd Reed City Mich

N

Nichols & Freeman Well Serv Box 183 Grandfalls Tex

O

Oliver Oil Well Serv 200 Berkley Ave Evansville Ind
Oien Oil Corp Box 2235 Cut Bank Mont
O'Loughlin Well Serv Co Box 93 Perry Okla

P

Payne Bros Drlg Co Box 15 Lawrenceville Ill
Penick Dean Casing Pulling Box 5174 Midland Tex
Perkins J E Inc Box 3143 Odessa Tex
Permian Serv Co Inc Box 1477 Levelland Tex
Permian Well Serv Inc Box 37 Wink Tex
Pool Well Serv Co Box 1940 San Angelo Tex
Post & Brown Well Serv Inc 208 S Main Stafford Kans
Prairie Drlg Co Box 2068 Casper Wyo
Price-Caudle Well Serv Inc Box 453 Seminole Okla

Q

Quad Drlg Co Box 974 Ardmore Okla

R

R & R Well Serv Co Inc Box 637 Rangely Colo
Ramey Well Serv 401-P Robertson Bldg Wichita Falls Tex
Reames S S Well Serv Box 387 Bloomfield N M
Rodgers Ed Oil Well Serv Box 206 Holyrood Kans
R O W S Co Inc Box 369 Russell Kans
Rush Well Serv Box 521 Lyons Kans
R W I T Drlg Co Box 551 Holdenville Okla

S

Sadie Workover Inc Box 877 Jena La
Savely Workover & Drlg Inc Box 407 Rosenberg Tex
Schaefer Well Serv Box 10 Victoria Tex
Seale Well Serv 306 W Wharton Electra Tex
Seifried Well Serv 117 S Wyandotte Dewey Okla
Shirer Well Serv Co Box 118 Hoisington Kans
Shreve Pipe & Supply Inc Box 7023 354 Areo Dr Shreveport La
Signal Oilfield Serv Inc 415 Petroleum Club Bldg Denver Colo
Simpson Wm G Well Serv Box 462 Robinson Ill
Chas A Sipes Well Serv Box 382 Russell Kans
Smallwood Drlg Co 3657 E Kiest Blvd Box 9365 Dallas Tex
Smith John W Well Serv Box 323 Lockport La
Spartan Well Serv 207 S-T Bldg Corpus Christi Tex
Spears Well Serv Inc Box 3187 Victoria Tex
Spur Well Serv Co Box 1325 Houston 1 Tex
Stafford Well Serv Box 147 Linch Wyo
Steen Drlg Co 619 West Bldg Houston 2 Tex
Steitle Drlg Co 1312 Southwood Dr Alice Tex
Stewart's Casing Crew Box 14086 Houston 21 Tex
Sunnyland Contracting Co Inc Box 388 Rayne La

T

T & H Well Serv Co Box 524 Eunice La
Taylor Dudley Elrod 118 Fifth Ave SE Cut Bank Mont
Texas Well Serv Co Box 191 Borger Tex
Thompson Beuford Prod Maintainers 2620 Bretton Rd Wichita Falls Tex
Thornbrugh Well Serv Co Box 541 Natchez Miss
Todd J R Co Inc Box 168 Odessa Tex
Turner's Well Serv Box 149 Centralia Ill

V

Virgil Well Serv Virgil Kans

W

W & C Well Serv 306 E Florida St Delhi La
WLB Drlg Co 6635 Chocolate Bayou Rd Houston 2 Tex
Wagner J H Drlg Co Box 751 Eldorado Kans
Weaver Well Service 1301 W Armory Blackwell Okla
Well Serv Inc 1901 E Virginia Ave Victoria Tex
Western Oil Well Serv Co Box 345 Glendive Mont
Winnsboro Well Serv Co Box 102 Winnsboro Tex
Wittman G W 223 McCulloch Bldg Okmulgee Okla
Wood Sam E Box 546 Alvin Tex

X

X-Pert Well Serv Inc Box 1225 Hobbs N M

U. S. Contract Well Servicing or Pulling Units

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity — Swabbing	Estimated Capacity — Pulling	Can Unit Also Drill?
ARKANSAS							
Clarksville							
Chris Well Serv Co Ltd	16	Crdwll KM-250	Truck	2	15,000	19,000/2⅛"	Yes
CALIFORNIA							
Bakersfield							
Adams Prod Serv	1	Wisn Spr	Trl	2	10,000	12,000/2" 9,000/2½" 6,000/3"	Yes
Calif Prod Serv Inc	M-21	Hopper	Hoistmobile	2	8,000	8,000	No
	M-22	Hopper	Hoistmobile	2	10,000	10,000	No
Robt B Doe Oilfield Serv	1	Crdwll H	Truck	1	4,500	5,000/2" 4,000/2½" 3,000/3"	No
	2	Crdwll HL	Truck	2	5,500	6,000/2" 5,000/2½" 4,000/3"	No
	3	Hopper	Truck	1	3,000	3,000/2" 2,000/2½" 1,500/3"	No
	4	Hopper	Truck	1	4,000	4,500/2" 3,500/2½" 2,500/3"	No
	5	Hopper	Truck	1	2,500	2,500/2" 1,500/2½" 1,000/3"	No
	6	Hopper IGFA	Truck	2	7,000	7,000/2" 6,000/2½" 5,000/3"	No
	7	Hopper IGFA	Truck	2	9,000	7,000/2" 6,000/2½" 5,000/3"	No
	9	Hopper IGFA	Truck	2	9,000	7,000/2" 6,000/2½" 5,000/3"	No
Drlg & Production Co	2	Crdwll	Trailer	2	15,000	14,000/2½"	Yes
	3	Ideco	Trailer	2	10,000	6,000/2½"	No
Castaic							
Calif Prod Serv Inc	D-2	Hopper MTA	Trailer	2	15,000	15,000	Yes
	D-4	Hopper MTA	Trailer	2	15,000	15,000	Yes
	H-3	Hopper G	Truck	2	10,000	10,000	Yes
	H-10	Wgnr Mrhse	Truck	2	10,000	10,000	Yes
	M-7	Hopper	Hoistmobile	2	8,000	8,000	No
	M-13	Hopper	Hoistmobile	2	10,000	10,000	No
Long Beach							
Calif Prod Serv Inc	H-1	Crdwll "R"	Truck	2	10,000	10,000	Yes
	H-5	Hopper G	Truck	2	10,000	10,000	Yes
	H-13	Wgnr Mrhse	Truck	2	10,000	10,000	Yes
	M-4	Hopper G	Trailer	2	10,000	10,000	Yes
	M-5	Ideco H-30	Trailer	2	10,000	10,000	Yes
	M-6	Hopper G	Trailer	2	10,000	10,000	Yes
	M-8	Wgnr Mrhse	Trailer	2	10,000	10,000	Yes
	M-14	Hopper	Hoistmobile	2	10,000	10,000	No
Finley Oilwell Serv Inc	1	Bender Guyless	Truck	2	12,000	10,000/2" 8,000/2½" 6,000/3"	Yes
	2	Bender Guyless	Truck	2	10,000	8,000/2" 6,000/2½" 4,000/3"	Yes
Macrate Prod Co	1	Ideco H-30	Trailer	2	10,000	12,000/2" 10,000/2½" 8,000/3"	Yes
	4	Wgnr-Mrhse	Trailer	2	10,000	12,000/2" 10,000/2½" 8,000/3"	No
	6	Wgnr-Mrhse	Trailer	2	10,000	12,000/2" 10,000/2½" 8,000/3"	No
	8	Wgnr-Mrhse	Trailer	2	12,000	14,000/2" 12,000/2½" 10,000/3"	Yes
Ventura							
Calif Prod Serv Inc	D-1	Hopper MTA	Trailer	2	15,000	15,000	Yes
	D-3	Hopper MTA	Trailer	2	15,000	15,000	Yes
	D-5	"Oilwell" 66	Truck	2	15,000	15,000	Yes
	D-6	Emsco 500	Truck	2	15,000	15,000	Yes
	M-9	Hopper	Hstble	2	10,000	10,000	No
	M-10	Hopper	Hstble	2	10,000	10,000	No

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity		Can Unit Also Drill?
					Swabbing	Pulling	
Wilmington							
Moore Prod Serv	1	Crdwll	Trailer	2	6,000	8,000/2" 6,000/2½" 5,000/3"	Yes
	2	Hopper Hoist	Truck	2	10,000	10,000/2" 10,000/2½" 9,000/3"	Yes
COLORADO							
Craig							
Atlas Well Serv Inc	3	Frnks Explr	Truck	2	8,000⅝"	10,000/2"	No
Fort Morgan							
Atlas Well Serv Inc	1	Frnks Rocket	Truck	2	8,000⅝"	10,000/2"	No
	2	Frnks Explr	Truck	1	—	10,000/2"	No
	4	Frnks Rocket	Truck	2	8,000⅝"	10,000/2"	—
Cortez							
R & R Well Serv Co Inc (Colo)	*7	Frnks 658-TD	Truck	1	13,500	16,000/2" 12,500/2½" 10,000/3"	Yes
	8	Frnks	Truck	1	13,500	—	No
	*9	Frnks 658 TD Explor	Truck	2	13,500	16,000/2" 12,500/2½" 10,000/3"	Yes
Rangely							
Colo Well Serv Inc	2	Frnks	Truck	2	—	—	—
	3	Frnks	Truck	2	12,000	12,000/2"	Yes
	4	Frnks	Truck	2	12,000	12,000/2"	—
	5	Frnks	Truck	2	—	—	—
R & R Well Serv Co Inc (Colo)	*1	Frnks 658-TD	Truck	1	13,500	16,000/2" 12,500/2½" 10,000/3"	Yes
	*2	Frnks 658-TD	Truck	2	13,500	16,000/2" 12,500/2½" 10,000/3"	Yes
	*3	Frnks 658-TD	Truck	1	13,500	16,000/2" 12,500/2½" 10,000/3"	Yes
	*4	Frnks 658-TD	Truck	1	13,500	16,000/2" 12,500/2½" 10,000/3"	Yes
	5	Frnks 658-TD	Truck	1	13,500	—	No
	*6	Frnks 658-TD	Truck	1	13,500	16,000/2" 12,500/2½" 10,000/3"	Yes
	11	Frnks 658-TD	Skid	1	13,500	16,000/2" 12,500/2½" 10,000/3"	No
Sterling							
Hayden & Griffith Oil Well Serv Co Inc	204	Frnks 658 DTD	Truck	—	10,000	14,000/2"	Yes
	205	Frnks 658	Truck	—	10,000	14,000/2"	Yes
ILLINOIS							
Bridgeport							
Geo H Baldwin Oil Well Serv	3	Cooper G-149	Truck	2	—	2,000	—
	1	Cooper G-226	Truck	1	—	2,500/3"	No
Centralia							
Raymond K Brake Well Serv	1	Vic	Truck	1	3,000	3,500/2½"	No
	2	Cooper	Turck	1	3,000	3,500/2½"	No
	3	Wisn Jr	Truck	1	1,500	1,600/2½"	No
	*4	Cooper W-226	Truck	2	3,000	3,500/2½"	Yes
	*5	Wisn Sup	Truck	2	5,000	5,000/2½"	Yes
	*6	Cooper 32-26-26	Truck	3	4,000	4,000/2½"	Yes
	7	Wisn Sup	Truck	1	5,000	5,000/2½"	No
Browning Well Serv Inc	258	Wich	Truck	—	—	4,500	No
Turner's Well Serv	1	Wisn Super	Truck	1	6,500	6,500	No
	2	Wisn Sr	Truck	1	4,000	4,000	No
	3	Wisn Sr	Truck	1	4,000	4,000	No
	4	Crdwll "Q"	Truck	1	4,000	4,000	No
	5	Ideco	Truck	1	6,500	6,500	No
Lawrenceville							
Payne Bros Drlg Co	*4	Crdwll	Skid	2	2,500	2,500	Yes
	*5	Crdwll	Skid	2	5,000	5,000	Yes
McLeansboro							
Browning Well Serv Inc	244	Wich	Truck	2	4,000	4,500	No
	259	Crdwll Q	Truck	—	—	4,000	No
	263	Wich	Truck	1	—	4,500	No
	264	Wisn	Truck	1	—	4,000	No
Bushby Well Serv	1	Wisn Sr	Truck	1	3,500	3,500	No
	2	Wisn Sr	Truck	1	3,500	3,500	No
	3	Wisn Sr	Truck	1	3,500	3,500	No
	4	Wisn	Truck	2	4,000	4,500	Yes
Marine							
Marine Well Serv	1	Fred Cooper	Truck	1	—	3,500/2½"	No
Monroe City							
Gwaltney Drlg Inc	1	Wisn Spr	Truck	1	4,000	4,000	No
	2	Crdwll Q	Truck	1	4,000	4,000	No
	3	Daney M	Truck	2	1,500	1,500	Yes
	4	Cooper	Skid	3	6,000	6,000	Yes
Robinson							
Wm G Simpson Well Serv	*4	Wisn Sr	Truck	2	4,000	3,500	Yes
	*5	Wisn Jr	Truck	2	2,500	2,900	Yes
	*6	Wisn Jr	Truck	2	2,500	2,500	Yes
	8	Wlkr-Nr	Truck	3	—	4,000	Yes
INDIANA							
Evansville							
Oliver Oil Well Serv	2	Crdwll Q	Truck	1	—	3,500	No
KANSAS							
Arkansas City							
Kent Well Serv Co Inc	10	Cooper P-32	Truck	2	4,500	5,000/2" 4,500/2½" 4,000/3"	No
Chase							
Chase Well Serv Inc	1	Frnks 4000TM	Truck	1	—	5,000/2" 4,500/2½" 3,600/3"	
El Dorado							
Kent Well Serv Co Inc	1	Cooper W-45	Truck	2	3,500	3,500/2" 3,200/2½" 2,800/3"	No
	2	Cooper W-45	Truck	1	—	3,500/2" 3,200/2½" 2,800/3"	No
	3	Cooper G-226	Truck	1	—	4,000/2" 3,700/2½" 3,500/3"	No
	4	Cooper W-45	Truck	1	—	3,500/2" 3,200/2½" 2,800/3"	No
	5	Cooper W-45	Truck	1	—	3,500/2" 3,200/2½" 2,800/3"	No
	6	Cooper W-45	Truck	1	—	3,500/2" 3,200/2½" 2,800/3"	No
	7	Cooper G-226	Truck	3	4,000	4,000/2" 3,700/2½" 3,500/3"	Yes
	8	Cooper W-45	Truck	1	—	3,500/2" 3,200/2½" 2,800/3"	No
	9	Cooper G-226	Truck	2	4,000	4,000/2" 3,700/2½" 3,500/3"	No
	11	Cooper W-45	Truck	1	—	3,500/2" 3,200/2½" 2,800/3"	No
	12	B Erie 22-W	Truck	2	800	1,200/2" 1,000/2½" 800/3"	Yes
	13	Cooper G-226	Truck	3	4,000	4,000/2" 3,700/2½" 3,500/3"	Yes
J H Wagner Drlg Co	*2	B Erie 36-L	Skid	3	4,500	4,500	Yes
	*3	B Erie 36-L	Skid	3	4,500	4,500	Yes
Eureka							
Barnard Well Service	*12	Cooper	Truck	3	3,000	3,000	Yes
Virgil Well Serv	4	Cooper WD	Truck	1	—	3,500	No
	5	Cooper WD	Truck	2	—	3,000	No
Garden City							
Post & Brown Well Serv Inc	23	Crdwll	Truck	1	7,000	6,000/2½"	No
	*25	Crdwll	Truck	2	7,000	6,000	No
Great Bend							
Dick Berry Well Serv	1	Crdwll HS-850	Truck	1	—	6,000/2" 5,500/2½" 4,500/3"	No
Chase Well Serv Inc	2	Frnks TM-44	Truck	1	—	6,000/2" 5,500/2½" 4,500/3"	—
Jetmar Well Serv	*1	Cooper E-563	Truck	2	7,000	10,000/2" 8,500/2½" 7,000/3"	Yes
Hoisington							
Shirer Well Serv Co	1	H Crdwll	Truck	1	—	—	No
	2	Frnks	Truck	1	—	—	No
	*3	H Crdwll	Truck	2	—	—	No

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Higher speeds and lighter weights in today's oil field power equipment make one type of chain insufficient for the demands of present oil rig operations. Morse has developed chains to answer *all* drive problems. For example, the high-speed efficiency of Hy-Vo® Drives permits lower-cost, high-speed, more mobile engines. And Morse overcomes metal fatigue with H.E. (high endurance) roller chain which outlasts ordinary chain by 5 times. So whatever your drive problem, look to Morse for a complete line of basic drives, speed reducers, couplings, and clutches. Write: Morse Chain Co., Dept. 7-31, Ithaca, N.Y. Export Sales: Borg-Warner International, Chicago 3, Illinois. In Canada: Morse Chain of Canada, Ltd., Simcoe, Ont.

MORSE

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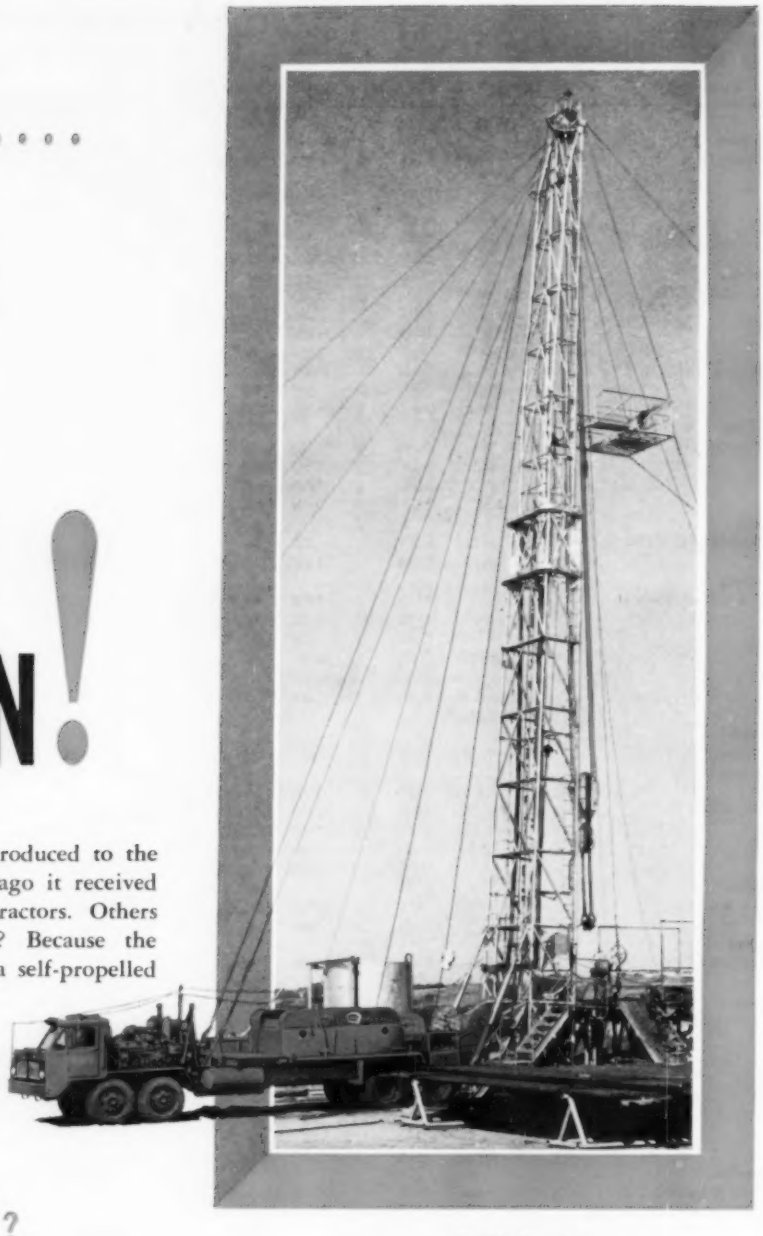
BW

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity Swabbing	Estimated Capacity Pulling	Can Unit Also Drill?
Holyrood							
Ed Rodgers Oil Well Serv	1	Crdwll HSKBS	Truck	—	5,000	5,000/2"	No
	2	Cooper E-563	Truck	—	5,000	5,000/2"	No
	3	Crdwll HSKBS	Truck	—	5,000	5,000/2"	No
Larned							
Post & Brown Well Serv Inc	7	Frnks	Truck	1	6,000	5,000/2½"	No
	15	Frnks	Truck	1	7,000	6,000/2½"	No
Lyons							
Rush Well Serv	3	Cooper 53	Truck	—	3,200	3,200/2"	No
	4	Cooper 51	Truck	—	3,200	3,200/2"	No
	5	Crdwll	Truck	—	3,200	3,200/2"	No
Madison							
Barnard Well Service	7	Cooper mdl W	Truck	1	—	3,000	No
	9	Cooper mdl W	Truck	1	—	3,000	No
	13	Cooper mdl W	Truck	1	—	3,000	No
	14	Cooper mdl W	Truck	1	—	3,000	No
	*16	Cooper mdl M	Truck	2	3,000	3,000	Yes
Medicine Lodge							
Clarke & Dennis Well Serv Inc	14	Crdwll AH	Truck	2	6,000	5,500	No
	15	Frnks	Truck	1	8,000	7,000	No
	16	Frnks	Truck	2	8,000	7,000	Yes
Moundridge							
Rush Well Serv	6	Crdwll	Truck	—	3,200	3,200/2"	No
Plainville							
Chase Well Serv Inc	3	Frnks TM-65	Truck	1	—	8,000/2"	—
						7,000/2½"	
						6,000/3"	
	4	Frnks TM-44	Truck	1	—	6,000/2"	—
						5,500/2½"	
						4,500/3"	
Pratt							
Chase Well Serv Inc	6	Frnks DTM	Truck	2	6,500	6,000/2"	No
						5,500/2½"	
						4,500/3"	
Russell							
Ivan Holt Well Serv	1	SRKR-6	Truck	1	—	8,000/3½"	No
	2	MZR	Truck	1	—	6,500/2½"	No
	3	SRKR-6	Truck	1	—	8,000/2½"	No
	4	Frnks 44DTM	Truck	2	—	6,500/2½"	No
R O W S Co Inc	4	Crdwll H	Truck	1	5,000	5,000/2"	No
Chas A Sipes Well Serv	1	Crdwll HS	Truck	—	—	4,500/2"	No
Stafford							
Post & Brown Well Serv Inc	6	Crdwll	Truck	1	6,000	5,000/2½"	No
	17	Frnks	Truck	1	6,000	5,000/2½"	No
	19	Frnks 44	Truck	1	6,000	5,000/2½"	No
	*26	Crdwll	Truck	2	6,000	5,000/2½"	Yes
LOUISIANA							
Undesignated							
La Fourche Workover & Drlg Co	1	Beth	barge	—	—	—	—
Delhi							
W & C Well Serv	*1	WIChtex HD C 60	Truck	2	6,500	5,000/2½"	Yes
						6,000/2"	
						4,000/3"	
	*2	WIChtex HD C 60	Truck	2	6,500	5,000/2½"	Yes
						6,000/2"	
						4,000/3"	
	*3	WIChtex HD C 60	Truck	2	6,500	5,000/2½"	Yes
						6,000/2"	
						4,000/3"	
	*4	Wlsn Spr 38 D	Truck	2	12,000	9,000/2½"	Yes
						10,000½"	
						8,000/3"	
De Soto							
Shreve Pipe & Supply Inc	1	Wlsn	Trailer	2	—	—	—
	*1	Gdnr-Den	—	—	3,500	7,000	Yes
Steen Drlg Co	2	Emsco	—	—	—	—	Yes
Empire							
Bayou Well Works Inc	Bge 1	Wlsn	Skid	1	14,000	—	No
Eunice							
T & H Well Serv Co	25	Wlsn Spr	Truck	1	12,000	—	No
	20	Wlsn Spr	Truck	1	—	10,000/2"	No
						8,000/2½"	
	18	Wlsn Spr	Truck	1	—	10,000/2"	
						8,000/2½"	No
	16	Wlsn Spr	Truck	1	12,000	—	No
	1	Wlsn Spr 38	Trailer	—	—	—	Yes
	3	Wlsn Spr	Truck	1	—	10,000/2"	No
	39	Wlsn Spr 38	Truck	1	10,000	8,000/2½"	Yes
	40	Wlsn Spr	Truck	1	12,300	—	No
	51	Wlsn Spr 38	Truck	1	—	10,000/2½"	Yes
	30	Wlsn Spr	Truck	1	—	10,000/2"	No
						8,000/2½"	
Harvey							
Gulf Tide Drlg Co	1	Wlsn Spr Gnt	Bge	—	15,000	15,000	Yes
Houma							
Bayou Well Works Inc	70	Wlsn Spr	Truck	1	12,500	—	No
Jena							
Sadie Workover Inc	1	Wlsn Super 38	Truck	1	—	10,000/2½"	Yes
	2	Unit Rig U-34D	Trailer	2	12,000	16,000/2½"	Yes
	3	Wlsn Mogul 42	Truck	1	10,000	—	No
	4	Wlsn Super	Truck	1	—	4,000/2½"	No
Jennings							
Holston Well Serv Inc	1	Wlsn Spr	Truck	—	10,500	—	No
	2	Wlsn Spr	Truck	—	10,500	—	No
	3	Wlsn Spr	Truck	—	10,500	—	No
	4	Wlsn Spr	Truck	—	10,500	—	No
	5	Wlsn Spr 38	Truck	—	—	13,000/2½"	No
	6	Wlsn Spr '39'	Truck	—	—	13,000/2"	No
	7	Wlsn Spr 38	Truck	—	—	13,000/2"	No
	*8	Wlsn Mogul	self-prop	—	—	16,000/2½"	Yes
	9	Wlsn Spr 38	self-prop	1	—	13,000/2"	No
Lafayette							
Black Gold Well Serv	1	Crdwll H	Skid	1	—	—	No
	2	Wlsn	Trailer	1	—	—*	No
	3	Crdwll L	Skid	1	—	—	No
Lockport							
John W Smith Well Serv	2	Frnks 658	self-prop	1	—	14,000/2½	Yes
New Iberia							
Bayou Well Works Inc	51	Wlsn	Truck	1	12,000	—	No
	120	Brwstr	Truck	1	15,000	—	No
	122	Wlsn Spr	Truck	1	12,500	—	No
New Orleans							
Bayou Well Works Inc	107	Frnks	Truck	1	12,500	—	No
Rayne							
Sunnyland Contr Co Inc	8	Crdwll D	Truck	1	10,000	13,000	Yes
Springhill							
Crusader Drlg & Serv Inc	4	Wlsn Spr	Truck	1	—	6,500/2½"	Yes
	5	Wlsn Spr	Truck	2	10,000	6,500/2½"	Yes
	7	Wlsn Spr	Truck	1	10,000	—	No
	8	Wlsn Spr	Truck	1	—	8,500/2½"	Yes
	11	Wlsn Spr 38	Truck	1	—	10,000/2½"	Yes
	13	Wlsn Spr	Truck	1	—	6,500/2½"	Yes
Sulphur							
L & W Well Serv	3	Cooper L-190	Truck	—	—	10,000/2"	Yes
	5	Cooper TC 4210	self-prop	1	—	10,000/2"	Yes
Venice							
Clinch Drlg Co	*1	Emsco 350	barge	—	12,000	16,000	Yes
MICHIGAN							
Reed City							
Mumy Well Serv	2	Crdwll "H"	Truck	1	6,000	5,000	No
	3	Frnks 1046	Truck	1	6,000	5,000	No
	4	Crdwll "D"	Truck	1	5,000	3,500	No
	5	Cooper "M"	Truck	1	6,000	5,000	No
MISSISSIPPI							
Undesignated							
Dapsco Inc	6	Beth S40	Truck	1	—	12,000	No
Baxterville							
Dapsco Inc	7	Franks 658	Truck	1	—	14,000	Yes
	8	Frnks 658	Truck	1	—	14,000	Yes
	9	Frnks 658	Truck	1	—	14,000	Yes
	10	Frnks 658	Truck	1	—	14,000	Yes
	11	Frnks 658	Truck	1	—	14,000	Yes
	12	Frnks 658	Truck	1	—	14,000	Yes
	14	Frnks 658	Truck	1	—	14,000	Yes
Index Drlg Co Inc	1	Wlsn 42	—	2	—	6,000	Yes
	2B	Beth S42	—	1	—	5,000	Yes
	3	Wlsn 42	—	2	—	9,000	Yes
Laurel							
Dapsco Inc	4B	Wlsn Spr	Truck	—	—	12,000	—
	5B	Wlsn Spr	Truck	—	—	12,000	—
	9B	Wlsn Spr	Truck	—	—	12,000	—
McComb							
W & C Well Service	*5	Wlsn Spr 38	Trailer	2	12,000	9,000/2½"	Yes
						10,000/2"	
						8,000/3"	
	*6	Wlsn Mogul	self-prop	1	15,000	16,000/2½"	Yes
						16,000/2"	
						10,000/3"	
	*7	Wlsn Spr 38	Truck	1	12,000	9,000/2½"	No
						10,000/2"	
						8,000/3"	
	8	Brwstr 170W	Skid	1	16,000	—	No
Natchez							
Thornbrugh Swabbing Co	1	Wlsn Mogul	Truck	1	12,500	—	No
	2	Cooper	Truck	1	12,500	—	No

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity		Can Unit Also Drill?
					Swabbing	Pulling	
MONTANA							
Cut Bank							
Dudley Elrod Taylor	*1	Western Gnt	Truck	2	4,000 4,000 8,000	4,000/2½" —	Yes
	3	Crdwll AH	Truck	2	7,000	5,000/2½"	No
	4	Frnks 26	Truck	1	—	3,200/2½"	No
	5	Frnks RD-190	Truck	11	4,000-⅝	10,000/2½	No
Glendive							
Signal Oilfield Serv Inc	2	Frnks 658/44	Truck	2	10,000	—	Yes
	*10	Frnks 658/65	Truck	2	12,000	—	Yes
	*16	Frnks 658/65	Truck	2	10,000	—	Yes
	14	Frnks 658/65	Truck	2	10,000	—	No
Western Oil Well Serv Co	1	Wlsn Torcair	Truck	—	14,000	14,000	Yes
	3	Wlsn Mogul	Truck	—	12,000	12,000	No
	5	Cooper 42-10	self-prop	2	14,000	14,000	No
Oilmont							
Olen Oil Corp	1	B Erie 36-L	Trailer	3	4,000	4,000	Yes
	2	B Erie 36-L	Trailer	3	4,000	4,000	Yes
	3	Natl T-20	Skid	1	7,000	10,000	Yes
	4	Beth S-50	Skid	1	3,500	4,000	Yes
Poplar							
Western Oil Well Serv Co	2	Wlsn Spr 38	Truck	—	12,000	12,000	No
	4	Wlsn Spr 38	Truck	—	12,000	12,000	Yes
Roundup							
H & H Oil Well Service	2	Frnks	Truck	1	8,000	6,000/2½"	No
	3	Brwstr	Trailer	2	8,000	8,000/2½"	No
	4	Frnks	Truck	1	—	4,000	No
	5	Wlkr-Nr C-34	Trailer	3	8,000	8,000	Yes
	6	Frnks	Truck	2	8,000	8,000	No
	7	Wlkr-Nr C-34	Trailer	3	8,000	8,000	Yes
NEBRASKA							
Kimball							
Hayden & Griffith Oil Well Serv Co Inc	201	Frnks 658 DTD	Truck	—	10,000	14,000/2"	Yes
	203	Frnks 658 DTD	Truck	—	10,000	14,000/2"	Yes
R O W S Co Inc	5	Crdwll K-200	Truck	2	12,000	12,000/2"	No
	6	Crdwll K-200	Truck	2	12,000	12,000/2"	No
	7	Hopper G A	Truck	2	15,000	15,000/2"	No
	9	—	Trailer	—	10,000	—	Yes
McCook							
R O W S Co Inc	2	Crdwll K-200	Truck	2	12,000	12,000/2"	No
	3	Crdwll H	Truck	1	5,000	5,000/2"	No
Trenton							
R O W S Co Inc	1	Crdwll H	Truck	1	5,000	5,000/2"	No
NEW MEXICO							
Artesia							
Neil Jackson & Sons	1	Wlsn	Truck	1	4,000	—	No
	2	Crdwll	Truck	2	3,500	3,500/2" 3,000/2½" 2,500/3"	No
	3	Wlsn Spr	Truck	2	6,000	6,000/2" 5,000/2½" 4,000/3"	No
	4	Frnks 658-137	Truck	2	12,000	12,000/2½"	No
Farmington							
Bivin & Smoot Drlg Co	3	Frnks Rocket	Truck	2	10,000	10,000/2" 10,000/2½" 7,500/3"	Yes
	5	Frnks Rocket	Truck	2	10,000	10,000/2" 10,000/2½" 7,500/3"	Yes
Calif Prod Serv Inc	H-4-M	—	—	—	—	—	—
	H-9-M	—	—	—	—	—	—
	M-2	Hopper G	Truck	2	10,000	10,000	Yes
Lohmann Oil Well Serv Inc	12	White 1283	Truck	—	10,500	10,500	No
	16	Intl L-190	Truck	—	10,500	10,500	No
	25	Frnks Expl	Truck	—	15,000	15,000	Yes
Signal Oilfield Serv Inc	*6	Frnks 65/44	Truck	2	8,000	—	Yes
	*15	Wlkr-Nr C-22	Truck	2	2,500	2,500	Yes
Hobbs							
Albright Well Serv Co	*12	Frnks 658	Truck	2	13,000	10,000	No
	*23	Frnks 658	Truck	2	13,000	13,000/2" 12,000/2½" 9,000/3"	Yes
	*27	Frnks 658	Truck	2	13,000	13,000/2" 12,000/2½" 9,000/3"	Yes
	*34	Frnks 658	Truck	2	13,000	13,000/2" 12,000/2½" 9,000/3"	Yes
	*44	Frnks 658	Truck	2	13,000	13,000/2" 12,000/2½" 9,000/3"	Yes
	*49	Frnks Rocket	Truck	2	13,000	15,000	No
Bateman & Whitsitt Inc	*1	Hopper Hoistmobile GXTA	self-prop	2	15,000	15,000/2" 13,000/2½" 10,000/3"	Yes
	*5	Hopper Hoist GXTA	self-prop	2	15,000	15,000/2" 13,000/2½" 10,000/3"	No
	10	Hopper GXFA	self-prop	2	15,000	14,000/2" 12,000/2½" 9,000/3"	No
	15	Frnks 658	self-prop	2	13,000	13,000/2"	No
	20	Frnks 658	self-prop	2	23,000	13,000/2"	No
	25	Frnks	self-prop	1	13,000	—	No
	30	Frnks 658	self-prop	2	13,000	13,000/2"	No
	*40	Frnks 658	self-prop	2	13,000	13,000/2"	No
	45	Hopper GXFA	Truck	2	15,000	14,000/2" 12,000/ ½" 9,000/3"	No
	50	Hopper GXFA	Truck	2	15,000	14,000/2" 12,000/2½" 9,000/3"	No
	55	Frnks 658	Truck	2	13,000	13,000/2"	No
	65	Frnks 658	Truck	2	13,000	13,000/2"	No
Clarke Oil Well Serv Co	1	Frnks 658	Truck	2	13,500	13,500/2"	No
	3	Frnks 658	Truck	2	13,500	13,500/2"	No
	4	Frnks 658	Truck	2	13,500	13,500/2"	No
	5	Frnks 658	Truck	2	13,500	13,500/2"	No
	6	Frnks	Truck	—	15,000	15,000/2"	No
	8	Hopper	Truck	2	15,000	15,000/2"	No
	9	Frnks 658	Truck	2	13,500	13,500/2"	No
	10	Frnks 658	Truck	2	11,500	13,000/2"	No
Craig Well Serv	1	Wlsn Mogul	Truck	2	13,000	13,000	Yes
	2	Cooper	Truck	2	13,000	13,000	Yes
J F McAdams	*38	Frnks 658	Truck	2	13,000	13,000	No
	*39	Frnks 658	Truck	2	13,000	13,000	No
	*47	Hooper	Truck	2	13,000	13,000	No
	*64	Frnks 658	Truck	2	12,500	12,500	No
	*65	Frnks 658	Truck	2	12,500	12,500	No
	*82	Frnks 658	Truck	2	13,000	13,000	No
	*83	Frnks Expl	self-prop	2	13,000	13,000	No
	*85	Wlsn Mogul	self-prop	2	13,000	13,000	No
X-Pert Well Serv Inc	43	Frnks 658	Truck	2	13,500	13,500	No
	45	Frnks 658	Truck	2	13,500	13,500	No
	46	Frnks 658	Truck	2	13,500	13,500	No
	48	Frnks 658	Truck	2	13,500	13,500	No
	49	Frnks 658	Truck	2	13,500	13,500	No
	50	Frnks 44 DTM	Truck	—	8,500	8,500	No
	51	Frnks Spr Clpr	self-prop	—	13,500	13,500	No
	52	Frnks 658	Truck	—	13,500	13,500	No
Jal							
Clarke Oil Well Serv Co	2	Frnks 658	Truck	2	12,000	14,000/2"	No
	7	Frnks	Truck	2	13,500	13,500/2"	No
	11	Frnks 658	Truck	1	—	14,000/2"	No
OHIO							
Upper Sandusky							
Lininger Oil & Gas Co	1	N Baltimore	Truck	1	2,000	2,500/2"	No
	2	N Baltimore	Truck	—	—	1,800/2"	No
OKLAHOMA							
Blackwell							
Weaver Well Serv	1	Crdwll	Truck	1	—	—	No
	2	Crdwll H	Truck	1	—	6,500/2" 5,500/2½"	No
	1	Wlkr-Nr S-43	Trailer	3	5,500	6,000/2" 5,000/2½" 5,000/3"	Yes
	2	Wlkr-Nr	Trailer	3	5,500	6,000/2" 5,000/2½" 5,000/3"	Yes
	1	Frnks DTM-44	Truck	2	7,800	7,500/2" 7,500/2½" 6,000/3"	No
	2	Frnks DTM 65	Truck	2	7,800	7,800/2" 7,500/2½" 6,000/3"	No
	3	Frnks DTM 44	Truck	2	7,800	7,500/2" 7,500"2½/ 6,000"3/	No
	4	Frnks DTM 44	Truck	2	7,800	7,500/2" 7,500/2½" 6,000/3"	No
Cherokee							
Weaver Well Serv	5	Frnks DTM 44	Truck	2	7,800	7,500/2" 7,500/2½" 6,000/3"	No

Franks Explorer....

NOW FULLY FIELD PROVEN!



When the Franks Explorer was first introduced to the well servicing industry some two years ago it received immediate acceptance from many contractors. Others assumed a wait-and-see attitude. Why? Because the Explorer was a totally new concept — a self-propelled unit primarily designed as a servicing and workover rig, and mounted on a rugged carrier for secondarily designed to over the road travel. Here was the promise of new speed, more horsepower, greater flexibility. The "wait-and-see" groups settled back to watch.

AND WHAT DID THEY SEE?

Within two short years they saw the Franks Explorer outsell all competition. They saw themselves joining that first group of contractors who accepted the Explorer immediately — who knew Franks' reputation for building good equipment and for delivering what is promised.

If you're still from Missouri, ask the man who owns a Franks' Explorer. Or, better still, call your Franks' representative for all the details.

WELL SERVICING AND DRILLING UNITS

FRANKS

PAMPA, TEXAS

CABOT

CABOT CORPORATION
MACHINERY DIVISION

Worth more when you BUY 'EM . . . Worth more when you TRADE 'EM

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity Swabbing	Estimated Capacity Pulling	Can Unit Also Drill?
Comanche							
Comanche Well Serv Co	1	S-32	Trailer	3	3,000	3,000	Yes
	2	P-22	Trailer	2	3,000	3,000	No
Dewey							
Seifried Well Serv	1	Cooper 226	Truck	1	—	3,000	No
	2	Cooper 226	Truck	1	—	3,000	No
	3	Cooper 226	Truck	2	3,000	3,000	No
	4	Cooper 226	Truck	1	—	3,000	No
	5	Crdwll	Truck	1	—	3,500	No
	6	Cooper 226	Truck	2	3,000	3,000	No
	7	Cooper 226	Truck	1	3,000	3,000	No
Drumright							
Cramer Well Serv	1	Frnks 65	Truck	2	6,000	7,500	No
	2	Frnks 65	Truck	2	6,000	7,500	No
	3	Frnks 65	Truck	1	—	7,500	No
	4	Frnks 65	Truck	1	—	7,500	No
	5	Frnks 65	Truck	2	6,000	7,500	No
	6	Frnks 65	Truck	2	6,000	7,500	No
	7	Cooper 1500	Truck	1	3,000	—	No
Elmore							
Quad Drlg Co	1	Frnks Gnt Clpr	self-prop	—	14,000	14,000	Yes
Hennessey							
Chris Well Serv Co Ltd	4	Frnks 658	Truck	2	11,500	14,000/2⅛"	No
	6	Frnks 658	Truck	2	11,500	14,000/2⅛"	No
	8	Frnks 658	Truck	2	11,500	14,000/2⅛"	No
Hominy							
Kent Oil Field Serv Inc	3	Cooper G-226	Truck	2	4,000	4,000/2" 3,700/2½" 3,500/3"	No
Laverne							
Pool Well Serv Co	14	Wlsn Spr 38	Truck	2	12,000	10,000/2½"	No
	15	Wlsn Spr 38	Truck	2	12,000	14,000/2½"	No
	19	Wlsn Spr	Truck	1	10,000	—	—
	25	Wlsn Spr 38	Trailer	2	14,000	12,000/2½"	No
	30	Wlsn Spr 38	Truck	2	12,000	14,000/2½"	No
	32	Wlsn	Self-prop	2	12,000	14,000/2½"	No
	40	Wlsn	Self-prop	2	12,000	14,000	No
Lindsay							
Chris Well Serv Co Ltd	3	Frnks 658	Truck	2	11,500	14,000/2⅛"	No
	5	Frnks 658	Truck	2	11,500	14,000/2⅛"	No
	14	Frnks 658	Truck	2	11,500	14,000/2⅛"	Yes
	19	Frnks Tri-Scope Derrick	Truck	2	11,500	14,000/2⅛"	No
	20	Crdwll KM-250	Truck	2	15,000	19,000/2⅛"	Yes
Christian Sarratt & Wallace Ltd	80	Crdwll KM-250	Truck	2	15,000	19,000/2⅛"	Yes
	81	Frnks 658	Truck	2	11,500	15,000/2⅛"	Yes
	82	Frnks 658	Truck	2	11,500	15,000/2⅛"	Yes
Oklahoma City							
Beckman Inc	—	MIW	self-prop	—		7,500/2½"	No
	—	MIW	self-prop	—	—	7,500/2½"	No
	—	Wlsn M-42	Trailer	—	—	8,000/2½"	Yes
	—	Wlsn M-42	Trailer	—	—	8,000/2½"	Yes
Chambless-Rosen Drlg Co	1	Crdwll RL	Skid	2	10,000	15,000/2"	—
	2	Crdwll RL	Skid	2	10,000	15,000/2"	—
	3	Crdwll RL	Skid	2	10,000	15,000/2"	—
Clark Well Serv Co	18	Frnks 44 DD	Truck	2	9,000	9,000	No
	20	Frnks 658 DD	Truck	2	12,000	12,000/2"	No
	21	Frnks 658 DD	Truck	2	12,000	12,000/2"	No
	22	Frnks 44 SD	Truck	1	10,000	—	No
	24	Frnks 658 DD	Truck	2	12,000	12,000/2"	No
	27	Frnks 658 DD Rkt	Truck	2	12,000	12,000/2"	Yes
	32	Frnks 658 DD Rck	Truck	2	12,000	12,000/2"	Yes
	33	Frnks 658 DD	Frnks Expl	2	12,000	12,000/2"	No
	34	Crdwll KM-20	—	2	—	—	—
Okmulgee							
Smallwood Drlg Co	1	B Erie 36-L	Trailer	2	—	7,600	Yes
Wittman Well Serv	1	Cooper 58	Truck	2	3,400	4,000/2" 3,300/2½" 3,000/3"	No
	2	Cooper 60	Truck	3	3,500	5,000/2" 4,000/2½" 4,000/3"	Yes
Pawhuska							
Kent Oil Field Serv Inc	1	Cooper W-45	Truck	2	3,500	3,500/2" 3,200/2½" 2,800/3"	No
	2	Cooper P-32	Truck	3	4,500	5,000/2" 4,500/2½" 4,000/3"	Yes
	6	Cooper W-45	Truck	1	—	3,500/2" 3,200/2½" 2,800/3"	No
	8	Cooper W-45	Truck	2	3,500	3,500/2" 3,200/2½" 2,800/3"	No
	10	Cooper W-45	Truck	1	3,200	3,500/2" 3,200/2½" 2,800/3"	No
	11	Cooper W-45	Truck	1	—	3,500/2" 3,200/2½" 2,800/3"	No
	12	Cooper W-45	Truck	2	3,500/2	3,500/2" 3,200/2½" 2,800/3"	No
Perry County							
O'Loughlin Well Serv Co	101	Frnks 5000	Truck	2	7,000	7,000	No
	102	Frnks 5000	Truck	2	7,000	7,000	No
	103	Frnks 5000	Truck	1	7,000	7,000	No
Ponetoc							
R W I T Drlg Co	1	Mayhew 1000	—	—	—	1,500/2⅛"	—
Sapulpa County							
R L Carpenter	1	Cooper W	Truck	1	3,000	3,000/2" 2,500/2½" 2,000/3"	No
Seminole County							
McDaniel Well Serv	1	Frnks 65-DTM	Truck	2	6,500	10,000/2" 6,500/2½"	No
	2	Frnks 65-DTM	Truck	2	6,500	10,000/2" 6,500/2½"	No
	3	Frnks 44-DTM	Truck	2	5,500	10,000/2" 6,500/2½"	No
Price-Caudle Well Serv Inc	1	Frnks 65	Truck	1	—	10,000/2" 10,000/2½" 10,000/3"	No
	3	Frnks 44	Truck	2	8,000	10,000/2" 10,000/2½" 10,000/3"	Yes
R W I T Drlg Co	1	Brwstr N-3	—	—	—	3,750/3½"	—
Shidler County							
Kent Oil Field Serv Inc	4	Cooper G-226	Truck	2	4,000	4,000/2" 3,700/2½" 3,500/3"	No
TEXAS							
Abilene							
Galloway Bros	4	Wich Engr	Truck	—	—	—	No
John Haseman Inc	2	Wlsn Spr	Truck	—	6,000	6,000	Yes
McDonald Well Serv Co	1	Frnks 44-DTM	Truck	2	8,500	9,000/2" 6,000/2½"	Yes
	2	Frnks 44-DTM	Truck	2	8,500	10,000/2" 7,000/2½"	Yes
	3	Wlsn Spr 38	Truck	2	8,500	10,000/2" 7,000/2½"	Yes
	4	Wichtex C-60	Truck	2	5,500	4,500/2" 3,000/2½"	No
	5	Frnks 44-DTM	Truck	2	8,500	10,000/2" 7,000/2½"	Yes
	6	Frnks 44-DTM	Truck	2	8,500	10,000/2" 7,000/2½"	Yes
Alice							
Crews Well Serv	*3	Wlsn Spr 38	Trailer	2	8,000	10,000	Yes
Alvin							
Sam E Wood	1	Ideco H-20	Truck	2	—	11,000/2" 9,000/2½"	Yes
Andrews County							
D & J Serv Inc	6	Frnks Expl	self-prop	2	14,000	14,000/2" 13,000/2½" 12,500/3"	Yes
	7	Frnks Expl	self-prop	2	14,000	14,000/2" 13,000/2½" 12,500/3"	Yes
	17	Frnks Expl	self-prop	2	14,000	14,000/2" 13,000/2½" 12,500/3"	Yes
Devonian Well Serv	9	Frnks 658	Truck	2	14,000	41,000	No
	10	Frnks 658	Truck	2	14,000	14,000	No
Carl S Ham Inc	3	Crdwll K-200	Truck	2	13,500	13,500	Yes
	6	Crdwll K-200	Truck	2	13,500	13,500	Yes
	5	Crdwll K-200	Truck	2	13,500	13,500	Yes
	7	Crdwll K-200	Truck	2	13,500	13,500	Yes
	8	Crdwll K-200	Truck	2	13,500	13,500	Yes
J E Perkins Inc	4	M-CSCO U-15	Skid	1	—	14,000/2½" 12,000/2⅛"	Yes
	5	Wlsn Gnt	Skid	1	—	13,000/2½" 12,000/2⅛"	Yes

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity		Can Unit Also Drill?
					Swabbing	Pulling	
Permian Serv Co Inc	10	Wlsn Spr 38	Truck	2	12,500	12,500/2″ 10,000/2½″ 6,000/3″	No
	12	Wlsn Spr 38	Truck	2	12,500	12,500/2″ 10,000/2½″ 6,000/3″	No
	14	Wlsn Spr 38	Truck	2	12,500	12,500/2″ 10,000/2½″ 6,000/3″	No
Pool Well Serv Co	10	Wlsn Spr 38	Truck	2	12,000	10,000/2½″	No
	12	Wlsn Spr 38	Truck	2	12,000	10,000/2½″	No
	22	Wlsn Mogul 42	Trailer	2	14,000	14,000/2½″	No
	36	Wlsn	self-prop	2	12,000	14,000	No
Bay City							
Spur Well Serv Co	3	Frnks 137	Truck	1	—	15,000/2½″	Yes
J P Graham	12	Wlsn Spr	Truck	—	9,000	—	No
	18	Wlsn Spr	Truck	—	10,000	—	No
	26	Wlsn Spr	Truck	—	9,000	—	No
	31	Wlsn Spr	Truck	—	9,000	—	No
Spur Well Serv Co	4	Frnks 658 TD	Truck	1	—	15,000/2½″	Yes
Steen Drlg Co	1	EMSCO	—	—	—	—	Yes
	3	EMSCO	—	—	—	—	Yes
Baytown							
Beall Well Serv Co	2	Natl T-8	Truck	1	—	10,000	No
	3	Crdwll KS	Truck	—	6,500	10,000/2″	No
Moore Petroleum Serv	3	Crdwll K	Skid	2	8,000	8,000	Yes
	8	Wlsn Mogul	Skid	1	5,000	5,000	Yes
Beaumont							
Steen Drlg Co	4	Ideco	—	—	—	—	Yes
Beeville							
Fish Oil Well Serv	1	Wlsn Spr	Truck	1	—	7,500/2″ 6,000/2½″	No
	2	Ideco	Truck	1	8,000	—	No
	*3	Wlsn Spr 38	Truck	2	9,500	10,000/2″ 10,000/2½″	Yes
	*4	Skytop	Truck	1	—	12,000	Yes
Big Lake							
Pool Well Serv Co	1	Wlsn Spr	Truck	2	10,000	8,000/2½″	No
	11	Wlsn Spr 38	Truck	2	12,000	10,000/2½″	No
	17	Wlsn Mogul	Truck	2	14,000	14,000/2½″	No
	24	Wlsn Spr	Truck	1	10,000	—	No
	38	Wlsn	self-prop	2	12,000	14,000	No
Breckenridge							
Dollins Bros Oil Well Serv Co	1	Wlsn	Truck	2	10,000	10,000	Yes
	2	Wich	Truck	2	8,000	8,000	Yes
Bridgeport							
John Haseman Inc	4	Crdwll K-200	Truck	—	6,000	6,000	Yes
Bryson							
Eichler Well Serv	5	Wichtex C-65	Truck	2	6,000	6,0002″	No
	6	Wichtex C-65	Truck	2	6,000	—	Yes
Cushema							
B & H Well Serv Inc	3	Wlsn Sr	Truck	2	6,000	5,000	No
	10	Wlsn Sr	Truck	2	6,000	5,000	No
	12	Wlsn Sup	Truck	—	10,000	10,000	No
	14	Wlsn Sr	Truck	2	—	6,000	No
	*16	Wlkr-Nr C-32 Spdr	Truck	3	4,000	4,000	Yes
Corpus Christi							
Spartan Well Serv Inc	1	Crdwll KL	Truck	1	6,000	10,000/2″ 8,000/2½″ 6,500/3″	Yes
Crane							
J R Todd Co Inc	4	Crdwll AL	Truck	2	9,000	8,000/2″ 6,000 /2½″ 4,500/3″	No
	6	Crdwll K-200	Truck	2	13,000	13,000/2″ 12,000/2½″ 10,000/3″	Yes
	7	Crdwll K-200	Truck	2	13,000	13,000/2″ 12,000/2½″ 10,000/3″	Yes
	8	Crdwll K-200	Truck	2	13,000	13,000/2″ 12,000/2½″ 10,000/3″	Yes
	9	Crdwll K-200	Truck	2	13,000	13,000/2″ 12,000/2½″ 10,000/3″	Yes
Devine							
Douglas V Downing Well Serv & Drlg.	1	Border	Truck	2	5,000	—	No
	2	Wlsn Super	Truck	2	5,000	—	Yes
	3	Wlsn Super	Truck	2	7,500	—	Yes
	4	Wlsn Super	Truck	2	10,000	—	Yes
	6	Wlsn Super	Truck	2	7,500	—	Yes
	7	Wlsn Super	—	—	10,000	—	Yes

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity		Can Unit Also Drill?
					Swabbing	Pulling	
Electra							
Seale Well Serv	1	Wich TE-2	Truck	1	—	2,000	No
	2	Wlsn Sr	Truck	2	4,000	3,000	No
	3	Wich TE-2	Truck	2	3,000	3,000	No
	4	Wich TE-2	Truck	2	3,000	3,000	No
	5	Wich C-65	Truck	2	7,000	6,500	No
Freer							
Douglas V Downing Well Serv & Drlg	5	Frnks	Truck	2	5,000	—	No
Steitle Drlg Co	1	Wlsn Mogul 42	Trailer	2	13,500	15,000/2″	Yes
Gainesville							
Barnes Bros Well Serv	3	Clark 70-S	Trailer	3	6,500	6,500/2″	Yes
	4	Wich E-75	Truck	2	10,000	10,000/2″	No
	6	Wich C-65	Truck	2	9,000	9,000/2″	No
	7	Wich C-65	Truck	2	7,500	7,500/2″	No
	8	Frnks Comet137	Trailer	—	15,000	15,000/2″	Yes
	10	Frnks Comet	Trailer	—	15,000	15,000/2″	Yes
Graham							
Jess P Cross Drlg Contr	1	Wlsn Gnt	Skid	1	—	—	Yes
Grandfalls							
Dick Hamm Drlg Co	1	Wlkr-Nr S-32	Trailer	3	6,500	6,500	Yes
	2	Wlkr-Nr C-33	Truck	3	3,500	3,500	Yes
	3	B Erie 36-L	Trailer	3	4,500	4,500	Yes
Nichols & Freeman Well Serv	4	Wlsn Sr	Truck	2	4,500	5,000/2″ 4,000/2½″ 2,500/3″	No
	6	Wlsn Sr	Truck	2	4,500	4,000/2″ 3,500/2½″ 2,500/3″	No
	14	Wlsn Sr	Truck	2	5,000	5,000/2″ 4,000/2½″ 3,300/3″	No
	15	Wlsn Spr	Truck	1	—	8,000/2″ 5,000/2½″ 4,000/3″	No
	22	Wlsn Spr 38	Truck	2	11,000	10,000/2″ 10,000/2½″ 7,000/3″	No
Holiday							
Baggett Drlg Co	*1	Wlkr-Nr 37	Trailer	3	—	8,000	Yes
	*2	Wlkr-Nr 27	Truck	2	—	7,000	Yes
	*7	Wlkr-Nr 34	Trailer	3	—	8,000	Yes
	*4	Wlkr-Nr 27	Truck	2	—	7,000	Yes
Houston							
Carlton Well Serv	1	Frnks Hyd	Truck	1	—	—	No
	2	Frnks Hyd	Truck	1	—	—	No
	3	Frnks Hyd	Truck	1	—	—	No
Mac Drlg Co	5	Beth S-45-E	Trailer	2	7,000	20,000/2″ 16,000/2½″ 13,000/3″	Yes
Moore Petroleum Serv	1	Crdwll K	Truck	1	8 000	—	Yes
	2	Crdwll K	Truck	2	10,000	8,600	Yes
	*4	Crdwll M-200	self-prop	2	10,500	12,000	Yes
	*5	Crdwll L	Trailer	2	10,500	12,000	Yes
	*7	Crdwll M-200	self-prop	2	10,500	12,000	Yes
Stewart's Casing Crew	*1	Cooper E	Skid	1	—	8,000/2″ 6,500/2½″	Yes
	*3	Cooper 420	Truck	1	—	11,000/2″ 9,000/2½″	Yes
	*5	Cooper 420	Truck	1	—	11,000/2″ 9,000/2½″	Yes
	*6	Cooper 420	Truck	1	—	11,000/2″ 9,000/2½″	Yes
	7	Cooper TR-42	Truck	1	—	10,000/2″ 8,000/2½″	No
	8	Cooper AP-138	Truck	1	—	10,000/2″ 8,000/2½″	No
	*9	Frnks	Skid	1	—	10,000/2″ 8,000/2½″	Yes
WLB Drlg Co	2	Wlsn U-34	Trailer	1	—	20,000/2″ 18,000/2½″ 6,000/3″	Yes
Kamay							
J W (Johnny) Birdwell Well Serv	3	Wich C-65	Truck	2	6,500	6,500/2″	No
	4	Wlkr-Nr	Truck	1	—	6,500/2″	No
	5	Wich C-65	Truck	—	6,500	6,500/2″	No
	6	Wich C-65	Truck	—	6,500	6,500/2″	No
Kenedy							
Copeland & Fuller Well Serv	2	Cooper 38	Truck	2	9,000	11,000/2″ 9,500/2½″	Yes
	3	Wlsn Spr 38	Truck	2	9,000	10,000/2″ 8,500/2½″	Yes

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity Swabbing	Estimated Capacity Pulling	Can Unit Also Drill?
Kermit							
J E Perkins Inc	6	Wlsn Gnt	Skid	1	—	15,000/2½" 13,500/2⅞"	Yes
Pool Well Serv Co	27	Wlsn Mogul 42	Trailer	2	14,000	14,000/2½"	Yes
Kilgore							
Bivin & Smoot Drlg Co	2	Wlsn Mogul	—	2	11,500	10,000/2" 10,000/2½" 7,500/3"	Yes
Kimball							
Flint Rig Co	23	Frnks	Truck	2	6,000	12,000	—
	57	Frnks	Truck	2	6,000	12,000	—
	160	Derrick Hopper	—	2	8,000	14,000	—
Levelland							
D & J Serv Inc	8	Frnks Expl	self-prop	2	14,000	14,000/2" 13,000/2½" 12,500/3"	Yes
Permian Serv Co Inc	15	Wlsn Spr	Truck	2	10,000	8,500/2" 6,000/2½" 5,000/3"	No
	16	Frnks 44	Truck	2	10,500	9,000/2" 6,500/2½" 5,500/3"	No
	18	Frnks 658	Truck	2	13,000	13,000/2" 11,000/2½" 7,500/3"	No
Longview							
R D Dickinson & H F Richardson DBA Well Serv Co	1	Wlsn Spr	Truck	—	—	8,500	No
	2	Wlsn Spr	Truck	—	—	8,500	No
	3	Wlsn Spr	Truck	—	8,500	—	No
	4	Wlsn Spr	Truck	—	5,500	—	No
Midkiff							
Pool Well Serv Co	2	Wlsn Spr	Truck	2	12,000	8,500/2½"	No
	5	Wlsn Spr	Truck	2	12,000	8,500/2½"	No
	16	Wlsn Spr 38	Truck	2	12,000	10,000/2½"	No
	20	Wlsn Spr	Truck	2	10,000	8,000/2½"	No
	23	Wlsn Spr	Truck	1	10,000	—	No
	34	Wlsn	self-prop	2	12,000	14,000	No
Midland							
Basin Well Serv Inc	37	Hopper G	Trailer	—	15,000	12,000/2"	Yes
	38	Hopper G	Trailer	—	15,000	12,000/2"	Yes
	44	Hopper G	Truck	—	12,000	10,000/2"	No
	46	Hopper G	Truck	—	12,000	10,000/2"	No
C H Brockett Inc	1	Crdwll K	Truck	—	—	7,500/2"	No
	2	Crdwll KS	Truck	—	—	10,000/2"	No
	3	Wlsn Gnt	Truck	1	—	16,000/2"	No
Dean Penick Casing Pulling	1	Wlsn Spr	Truck	1	—	9,000/5½"	No
Mission							
J & M Well Serv	1-B	Wlsn Super	Truck	2	6,000	7,000/2½"	Yes
	6-B	Wlsn Super	Truck	2	6,000	7,000/2½"	Yes
	10	Cooper Skytop	self-prop	2	8,500	10,000/2½"	Yes
	11	Wlsn Winch	self-prop	2	10,000	16,000/2½"	Yes
	12	Wlsn Winch	self-prop	2	10,000	16,000/2½"	Yes
Nocona							
Jack Mercer Well Serv	2	Wlsn Sr	Truck	1	No	3,000/2"	No
	*7	Wich C-865	Truck	2	8,000	8,000/2"	Yes
	*8	Wich E-75	Truck	2	10,000	10,000/2"	Yes
	*15	Wich E-75	Truck	2	10,000	10,000/2"	Yes
	*18	Wich E-75	—	2	10,000	10,000/2"	Yes
	*20	Wich E-75	Truck	2	10,000	10,000/2"	Yes
	*33	Wich E-75	Truck	2	10,000	10,000/2"	Yes
Odessa							
Beckman Inc	1	Natl T-20	Trailer	—	8,000	—	Yes
	9	M-CSCO	Skid	—	12,000	—	Yes
	—	Wlsn M-42	Self-prop	2	8,000	—	Yes
Devonian Well Serv	2	Frnks 658	Truck	2	14,000	14,000	No
	3	Frnks 658	Truck	2	14,000	14,000	No
	6	Frnks 658	Truck	2	14,000	14,000	No
	7	Frnks 658	Truck	2	14,000	14,000	No
	8	Frnks 658	Truck	2	14,000	14,000	No
	11	Wlsn Giant	Truck	2	14,000	14,000	No
J E Perkins Inc	3	Wlsn Gnt	Skid	1	—	10,000/2½" 8,500/2⅞"	Yes
J R Todd Co Inc	1	Frnks 658-DTM	Truck	2	13,000	13,000/2" 12,000/2½" 10,000/3"	No
	2	Frnks 658-DTM	Truck	2	13,000	13,000/2" 12,000/2½" 10,000/3"	No
	3	Frnks 658-DTM	Truck	2	13,000	13,000/2" 12,000/2½" 10,000/3"	No
Olney							
F M Johnson Well Serv	1	Johnson 30	Truck	3	2,500	2,500	Yes
	2	Clark 30	Trailer	3	3,600	3,600	Yes
	3	Clark 30	Trailer	3	3,600	3,600	Yes
	4	Clark 30	Trailer	3	5,000	5,000	Yes
	5	Clark 30	Trailer	3	5,000	5,000	Yes
Pampa							
Flint Rig Co	114	Cooper	Truck	1	3,500	6,000	—
	136	Wlsn	Truck	2	3,500	8,000	—
	309	Frnks	Truck	1	—	10,000	—
Perryton							
Beckman Inc	—	Frnks	Self-prop	2	—	7,500/2½"	No
	—	Crdwll	Self-prop	2	—	7,500/2½"	No
	—	Crdwll	Self-prop	2	—	7,500/2½"	No
	—	Frnks	Self-prop	2	—	7,500/2½"	No
D & L Drlg & Serv	2	Frnks SAL-500	Trailer	2	10,500	10,500 w/rev cir	
	5	Frnks 658	Truck	2	—	12,500/2½"	—
	6	Frnks 658	Truck	2	—	12,500/2½"	—
Pettus							
Carter Well Serv	1	Wlsn Spr	Truck	2	10,000	9,500/2"	No
	2	Wlsn Spr	Truck	2	10,000	9,500/2"	No
	3	Wlsn Spr	Truck	2	10,000	9,500/2"	No
	4	Wlsn Skytop	Truck	2	10,000	9,500/2"	No
Pleasanton							
J E Hillier	3	Crdwll 250-KM	Self-prop	2	15,000	15,000/2½"	Yes
	3	Crdwll 25-KM	Self-prop	—	11,000	15,000/2"	Yes
Richmond							
Moore Petroleum Serv	*6	Crdwll K-202	Truck	2	10,000	10,000	Yes
Rio Grande							
J & M Well Serv	2	Cooper E-563	Truck	2	6,000	5,000/2½"	Yes
	3	Cooper E-563	Truck	2	6,000	5,000/2½"	Yes
	4	Wlsn Spr	Truck	2	6,000	7,000/2½"	Yes
	5	Wlsn Spr	Truck	2	6,000	7,000/2½"	Yes
	7	Wlsn Spr	Truck	2	6,000	7,000/2½"	Yes
	8	Wlsn Sr	Truck	2	6,000	4,000/2½"	Yes
	9	Cooper T-36	Truck	1	10,000	—	No
Rosenberg							
Savely Workover & Drlg Inc	4	Frnks Sr Clpr	Self-prop	1	—	1,200/2½"	Yes
	5	Frnks Sr Clpr	Self-prop	1	—	1,200/2½"	Yes
Royalty							
Locke Well Serv	*1	Wlsn Spr	Truck	2	12,000	12,000	Yes
	*2	Hopper	Truck	2	12,000	12,000	Yes
	*3	Wlsn Spr	Truck	2	8,000	8,000	Yes
Rule							
Acme Well Serv Co	1	Wich C-65	Truck	2	8,000	8,000/2"	Yes
	2	Wich C-65	Truck	2	8,000	8,000/2"	Yes
	3	Wich C-65	Truck	2	8,000	8,000/2"	Yes
San Angelo							
Pool Well Serv Co	4	Wlsn Spr	Truck	1	10,000	—	No
	6	Wlsn Spr	Truck	2	10,000	10,000/2½"	No
	26	Wlsn Spr	Truck	2	6,500	5,000/2½"	No
Saratoga							
Beall Well Serv Co	4	Natl T-8-S	Truck	2	8,000	10,000	No
Snyder							
B & H Well Serv Inc	1	Wlsn Sup 38	Truck	2	11,000	11,000	No
	2	Wlsn Sup	Truck	2	10,000	10,000	No
	5	Wlsn Sup 38	Truck	2	11,000	11,000	No
	6	Wlsn Sup 38	Truck	2	11,000	11,000	No
	9	Wlsn Sup 38	Truck	2	11,000	11,000	No
Stinett							
Tex Well Serv Co	1	B Erie 36-L	Skid	3	4,000	4,000	Yes
	2	B Erie 36-L	Skid	3	4,000	4,000	Yes
	3	Wich	Truck	2	3,500	3,500	Yes
	4	Wlkr-Nr C-33-A	Truck	3	3,500	3,500	Yes
Sulphur							
Emerson Well Serv Inc	*2	Wlsn Spr	Truck	1	10,000	7,500/2"	Yes
	*3	Wlsn Spr	Truck	1	10,000	7,500/2"	Yes
Sweetwater							
Pool Well Serv Co	21	Wlsn Spr	Truck	2	10,000	8,000/2½"	No
	28	Wlsn Spr 38	Truck	2	12,000	10,000/2½"	No
Victoria							
Schaefer Well Serv Inc	1	Skytop	Trailer	2	9,500	12,000/2" 10,000/2½"	Yes
	2	Vic	Trailer	2	10,000	15,000/2"	Yes
	3	Vic	Trailer	2	10,000	14,000/2"	Yes
Spears Well Serv Inc	1	Wlsn Spr	Truck	2	8,000	8,500/2" 6,500/2½"	Yes
	2	Wlsn Spr	Truck	2	8,000	8,500/2" 6,500/2½"	Yes
	3	Wlsn Spr	Truck	2	8,000	8,500/2" 6,500/2½"	Yes
	4	Wlsn Spr	Truck	1	8,000	—	—

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity Swabbing	Estimated Capacity Pulling	Can Unit Also Drill?
	5	Skytop Wltrwt	Truck	2	8,000	11,000/2" 8,000/2½"	Yes
	6	Skytop Wltrwt	Truck	2	8,000	11,000/2" 8,000/2½"	Yes
Well Serv Inc	1	Frnks	Trailer	1	—	8,500/2"	—
	2	Frnks	Trailer	1	—	8,500/2"	—
	3	Frnks	Trailer	1	—	8,500/2"	—
	4	Crdwll	Trailer	1	8,000	—	—
	5	Skytop	Trailer	2	—	9,500	—
Whitesboro							
Jack Mercer Well Serv	*6	Wich E-74	Truck	2	10,000	10,000/2"	Yes
Wichita Falls							
McAlister Well Serv	7	Wlsn Spr	Truck	2	7,500	7,500/2"	No
	10	Wlsn Spr	Truck	2	7,500	7,500/2" 6,500/2½"	No
	20	C-25	Truck	2	7,500	7,500/2" 6,500/2½"	Yes
	42	Wich	Truck	2	6,000	5,000/2" 3,600/2½"	No
	45	Wich	Truck	1	—	5,000/2" 3,000/2½"	No
Ramey Well Serv	1	Wich E-75	Truck	2	8,000	14,000/2" 12,000/2½" 10,000/3"	Yes
	2	Wich E-75	Truck	2	8,000	14,000/2" 12,000/2½" 10,000/3"	Yes
	3	Wich C-60	Truck	2	5,200	6,500/2"	No
Windthorst							
Beuford Thompson Prod Maintainers	2	Wich C-65	Truck	2	6,500	6,500/2"	Yes
Wink							
Ideal Casing Co	3	Jack Knife	Skid	1	—	11,000	Yes
Permian Well Serv Inc	1	Crdwll	Skid	2	12,000	12,000/2"	Yes
	2	Wlsn Spr	Truck	2	12,000	11,000/2"	No
	3	Wlsn Spr	Truck	2	10,000	9,000/2"	No
	5	Crdwll	Truck	1	—	5,000/2"	No
	6	Wlsn Spr	Truck	2	10,000	9,000/2"	No
	7	Wlsn Spr	Truck	2	—	12,000	—
Winnsboro							
Winnsboro Well Serv Co	F-1	Frnks Rocket 44	Truck	2	6,500	8,500/2" 7,200/2½"	Yes
	F-2	Frnks Rocket 44	Truck	2	6,500	8,500/2" 7,200/2½"	Yes
	F-5	Frnks Spr 65	Truck	1	—	8,500/2" 7,500/2½"	Yes
	F-6	Frnks 65	Truck	1	—	8,500/2" 7,500/2½"	Yes
	W-4	Wlsn Spr	Truck	1	†8,500	—	—
Winters							
Pool Well Serv Co	3	Wlsn Spr	Truck	2	10,000	8,000/2½"	No
	7	Wlsn Spr	Truck	2	10,000	8,000/2½"	No
	8	Wlsn Sr	Truck	2	6,500	5,000/2½"	No
	9	Wlsn Sr	Truck	2	6,500	5,000/2½"	No
	29	Wlsn Spr	Truck	2	10,000	8,000/2½"	No
UTAH							
Red Wash							
R & R Well Serv Co Inc (Colo)	*10	Frnks TD-658	Truck	2	13,500	16,000/2" 12,500/2½" 10,000/3"	Yes
Vernal							
Calif Prod Serv Inc	M-3	Hopper G	Trailer	2	10,000	10,000	Yes
WYOMING							
Casper							
M E Billings Well Serv Inc	2	Frnks DD Rokt Explorer	Cran Carrier	—	10,000	13,000/2"	Yes
Capshaw Well Serv Co	1	Crdwll	Truck	2	10,000	10,000/2½"	No
	2	Crdwll	Self-prop	2	14,000	14,000	No
Thompson & Galloway	2	Okla Mach & Supply	Truck	1	—	—	No
Capshaw Well Serv Co	3	Crdwll KM-210	Truck	2	15,000	15,000	No
Cody							
D & S Well Serv	1	Wlsn Spr 38	Truck	2	10,500	12,500	Yes
	2	Wlsn Spr 38	Self-prop	2	12,500	15,000	Yes
	3	Wlsn Spr	Truck	2	8,500	8,000	Yes
Gillette							
Stafford Well Serv	*44	Frnks 658	Truck	2	13,000	13,000	Yes
	*73	Frnks 658-44	Truck	2	13,000	13,000	Yes
Glenrock							
Dyer Drlg Co	1	Natl T-32	Skid	2	6,000	—	Yes
	2	M-CSCO	Truck	—	—	—	Yes
	3	Wich C-60	Truck	2	7,000	8,000/2" 7,000/2½" 5,500/3"	—
	4	Failing	Truck	—	4,500	—	Yes
	6	Wlsn Torcair	Trailer	2	9,000	10,000/2" 10,00002½" 9,000/3"	—
Linch							
Stafford Well Serv	*61	Frnks 658-44	Truck	2	13,000	13,000	—
	*79	Frnks 60	Truck	2	8,000	8,000	Yes
	*81	Frnks 60	Truck	2	11,000	11,000	Yes
Powell							
Dicks Well Serv Co	8	Frnks & Cooper	Truck	2	10,000	10,000	No
Weston							
Prairie Drlg Co Inc	1	Crdwll RS	Skid	—	—	—	Yes

Canadian Well Servicing Contractors

Beta Well Serv Ltd 5930—96 St Edmonton Alberta Canada
Chupp Well Serv Ltd 525A Seventh Ave SW Calgary Alberta Canada
Flint Rig Co Ltd 5th Fl Natural Gas Bldg Calgary Alberta Canada
Mac Lean Well Serv Ltd Drayton Valley Alberta Canada
Prairie Well Serv Co Ltd Box 4177 Edmonton Alberta Canada
Raines Well Serv Ltd 11166—73rd Ave Edmonton Alberta Canada
Widney Oil & Drlg Co Ltd 6328—104th St Edmonton Alberta Canada

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity Swabbing	Estimated Capacity Pulling	Can Unit Also Drill?
ALBERTA							
Devon							
Widney Oil & Drlg Co Ltd	6	Slsn Spr	Truck	2	9,000	8,000/2" 6,500/2½" 4,000/3"	Yes
	10	Frnks Rocket 44	Truck	2	9,000	8,000/2" 6,500/2½" 4,000/3"	Yes
Drayton Valley							
Beta Well Serv Ltd	6	Crdwll AH	Truck	2	—	6,000/2" 5,000/2½"	Yes
	8	Crdwll K-201	Truck	2	—	10,000/2" 8,500/2½"	Yes
Mac Lean Well Serv Ltd	1	Crdwll AH	Truck	2	6,500	6,000/2"	Yes
	2	Crdwll AH	Truck	2	6,500	6,000/2"	Yes
	3	Cooper Skytop	Truck	2	10,000	10,000/2"	Yes
Raines Well Serv Ltd	2	Cooper TD	Self-prop	2	10,000	10,000	No
Widney Oil & Drlg Co Ltd	16	Frnks Expl	Truck	2	9,000	8,000/2"	Yes
	16	Frnks Expl	Truck	2	9,000	8,000/2" 6,500/2½" 4,000/3"	Yes

Canadian Contract Well Servicing or Pulling Units

Contractor's Name	Rig No.	Make Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity Swabbing	Estimated Capacity Pulling	Can Unit Also Drill?
Edmonton							
Prairie Well Serv Co Ltd	1	Crdwll H	Truck	1	6,000	6,000/2" 5,000/2½" 4,000/3"	No
	2	Crdwll H	Truck	1	6,000	6,000/2" 5,000/2½" 4,000/3"	No
	4	Ideco 50-60	Truck	2	7,000	7,000/2" 6,000/2½" 5,000/3"	Yes
	5	Crdwll KL	Skid	2	15,000	12,000/2" 10,000/2½" 7,000/3"	Yes
	6	Crdwll RL	Skid	2	14,000	14,000/2" 12,000/2½" 10,000/3"	Yes
	9	Frnks	Truck	2	14,000	14,000/2" 12,000/2½" 10,000/3"	Yes

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity Swabbing	Estimated Capacity Pulling	Can Unit Also Drill?
Red Deer							
Chupp Well Serv Ltd	2	Ideco M-25-D	Truck	2	—	10,000	—
	3	Wich C-60	Truck	1	5,000	5,000/2"	No
	*4	Wich C-65	Truck	2	7,500	7,000/2"	No
	*5	Ideco M-25-D	Truck	2	10,000	10,000/2"	Yes
Redwater							
Beta Well Serv Ltd	2	Crdwll H	Truck	1	—	5,000/2" 4,000/2½"	Yes
	3	Crdwll Mobilhst	Truck	2	—	5,000/2" 4,000/2½"	Yes
Rimbey							
Widney Oil & Drlg Co Ltd	1	Ideco H-20	Truck	2	9,000	10,500/2" 9,000/2½" 5,500/3"	Yes
Stettler							
Prairie Well Serv Co Ltd	3	Crdwll	Self-prop	2	6,500	6,500/2" 5,500/2½" 4,500/3"	Yes
Valleyview							
Widney Oil & Drlg Co Ltd	12	Ideco H-35	Self-prop	2	15,000	18,000/2" 15,000/2½" 8,000/3"	Yes
	15	Wlsn Super	Truck	—	10,000	12,000/2" 10,000/2½" 6,000/3"	Yes
Virginia Hills							
Prairie Well Serv Co Ltd	10	Cooper	Self-prop	2	9,000	10,000/2" 9,0002/½" 7,000/3"	Yes

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity Swabbing	Estimated Capacity Pulling	Can Unit Also Drill?
MANITOBA							
Virden							
Flint Rig Co Ltd	55	Wlsn	Truck	2	8,000	—	Yes
	280	Crdwll HS	Truck	1	3,600	—	No
	293	Cooper	Truck	1	3,600	—	No
	307	Frnks DTM-44	Truck	2	6,000	—	Yes
SASKATCHEWAN							
Estevan							
Flint Rig Co Ltd	320	Frnks DTM-44	Truck	2	6,000	—	Yes
	353	Cooper	Truck	2	8,000	—	Yes
Oxbow							
Widney Oil & Drlg Co Ltd	7	Cooper W-226	Truck	2	5,000	3,000/2½"	No
	8	Wlsn Spr	Truck	2	9,000	8,000/2" 6,500/2½" 6,500/2½" 4,000/3"	Yes
	9	Wlsn Spr	Truck	2	9,000	8,000/2" 6,500/2½" 4,000/3"	Yes
	11	Frnks Rocket 44	Truck	2	9,000	8,000/2" 6,500/2½" 4,000/3"	Yes
	14	Frnks Rocket 44	Truck	2	9,000	8,000/2" 6,500/2½" 4,000/3"	Yes
Swift Current							
Flint Rig Co Ltd	290	Crdwll AH	Truck	2	6,000	—	Yes
	317	Frnks DTM-44	Truck	2	6,000	—	Yes

Too Late for Alphabetical Listings

Rotary

Brack Drlg Co. Inc Box 575 Fort Collins Colo
Exploration Drlg Co Box 406 Whittier Calif
Gillespie Glenn & Sons Inc Box 907 Cushing Okla
Houston Oil Well Service Co 504 Waugh Dr Houston 19 Tex
Nicklos Drlg Co 518 First City Natl Bk Bldg Houston 2 Tex
Service Drlg Co 1307 S Boulder Tulsa Okla
K Smith Cable Tools 1801 Van Buren Great Bend Kans
Rine Drlg Co of Canada Ltd 534 8th Ave SW Calgary Alberta Canada
Souris Serv Co Ltd Box 1138 Estevan Saskatchewan

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
ARKANSAS						
Yell County						
Service Drlg Co	16	gas	1600	Wlsn Spr Titan	1600	18,000
KANSAS						
Barton County						
Brack Drlg Co Inc (Colo)	*1	dsl	—	M-CSCO U-15	330	5,800
Russell County						
K Smith Cable Tools	*—	gas	—	Wlkr-Neer S-32	140	4 800
LOUISIANA						
St Mary Parish						
Nicklos Drlg Co	11	stm	—	Natl	—	17,000
	18	gas-btne	—	Natl 110	1600	17,000
Iberia Parish						
Nicklos Drlg Co	14	gas-btne	—	Natl 75	1000	12,000
Vermilion Parish						
Nicklos Drlg Co	15	gas-btne	—	Natl 80	1000	13,000
La Fourche Parish						
Nicklos Drlg Co	12	stm	—	Natl	—	17,000
St Landry Parish						
Nicklos Drlg Co	10	stm	—	Natl	—	17,000
Assumption Parish						
Nicklos Drlg Co	23	gas-btne	—	Natl 125	2025	20,000
OHIO						
Portage County						
Glenn Gillespie & Sons Inc	*8	LP gas	—	Cpr Skytop 66	200	—
Stark County						
Glenn Gillespie & Sons Inc	*7	dsl	—	Frnks 658 TRD	225	3,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Kingfisher County						
Glenn Gillespie & Sons Inc	*1	gas	370	M-CSCO U-34	300	6,500
	*6	dsl	400	M-CSCO U-34	300	6,500
Summit County						
Glenn Gillespie & Sons Inc	*3	dsl	275	Wlsn Mogul	275	6,500
	*2	dsl	375	Wlsn Mogul	275	6,500
OKLAHOMA						
Beaver County						
Service Drlg Co	3	gas	700	M-CSCO U-15	700	8,500
Cimarron County						
Service Drlg Co	*8	gas	320	M-CSCO U-34	320	6,700
McClain County						
Service Drlg Co	14	gas	1000	Wlsn Titan	1050	15,000
TEXAS						
Colorado County						
Houston Oil Well Serv Co	4	gas-btne	—	Ideco M-10,000	855	10,000
Gray County						
Service Drlg Co	9	dsl	290	Natl T-12	300	4,000
Hartley County						
Service Drlg Co	*2	gas	296	M-CSCO U-34	200	6,000
Hansford County						
Service Drlg Co	12	gas	700	Wlsn Super	700	11,000
Hemphill County						
Service Drlg Co	17	gas	700	Wlsn Super	700	11,000
Hutchinson County						
Service Drlg Co	*1	dsl	180	M-CSCO U-34	180	4,500
Liberty County						
Houston Oil Well Serv Co	2	dsl	—	Wlsn Titan	1000	10,000
Moore County						
Service Drlg Co	6	gas	295	N-4 Brwstr	230	5,000
Oldham County						
Service Drlg Co	10	gas	202	M-CSCO U-22	190	4,500
Potter County						
Service Drlg Co	*11	gas	160	All-Trailer	140	3,000
UTAH						
Duchesne County						
Delta Drlg Co	50	gas	800	Beth S-60	488	8,000
WYOMING						
Sweetwater County						
Delta Drlg Co	48	gas	310	Beth S-60	450	7,000

Contractor's Name	Rig No.	Type Power	Total HP All Main Mud Pumps	Drawworks Make and Model	Total HP Available to Drwwks	Rated Depth with 4½" Pipe
Park County						
Delta Drlg Co	*52	gas	310	Beth S-50	225	5,500
Weston County						
Delta Drlg Co	49	gas	725	M-CSCO U-15	600	8,000
Bottineau County						
Delta Drlg Co	*53	gas	310	Beth S-50	225	5,500
Washakie County						
Delta Drlg Co	51	gas	725	Natl 75	600	9,000

Canadian Rotary Rigs

ALBERTA						
Hamilton Lake						
Rine Drlg Co of Canada Ltd	3	dsl	200	Crdwll L	248	4,000
Gilby						
Rine Drlg Co of Canada Ltd	1	dsl	300	Brwstr N-45-M	230	7,500
SASKETCHEWAN						
Oxbow						
Souris Serv Co Ltd	5	—	—	Mayhew 2000	—	5,000
	4	—	—	Mayhew 2000	—	5,000

Well Servicing

Gamache Well Serv Ltd 12-11244 116th St Edmonton Alberta Canada
Redwell Serv Co Ltd 6530 100th St Edmonton Alberta Canada
Oil Well Serv Co 2405 Orange Ave Long Beach 6 Calif
Gillespie Glenn & Sons Box 907 Cushing Okla
Kinsey & Ham Inc 2004 N C St Midland Tex

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity Swabbing	Estimated Capacity Pulling	Can Unit Also Drill?
CALIFORNIA							
Bakersfield							
Oil Well Serv Co	1-A	Ideco 40	Trailer	2	13,000	13,000/2½" 10,000/3"	Yes
	2-A	Ideco 40	Trailer	2	13,000	13,000/2" 10,000/3"	Yes
	11	Ideco 30	Trailer	2	10,000	10,000/2½"	Yes
	12	Crdwll	Trailer	2	5,000	5,000/2½" 4,000/3"	Yes
	15	Ideco 30	Trailer	2	13,000	13,000/2½" 8,000/3"	Yes
	57	Ideco 35	self-prp	2	13,000	13,000/2½" 8,000/3"	Yes
Kerman							
Oil Well Serv Co	41	Ideco 30	Trailer	2	10,000	10,000/2" 7,000/3"	—
	60	Ideco H-25 CD	self-prp	2	11,500	10,000	Yes
	A-4	Ideco 30	Trailer	2	10,000	10,000/2½" 7,000/3"	Yes
Long Beach							
Oil Well Serv Co	2	Wlsn Mogul	Truck	1	—	12,000/2½"	Yes
	3	Ideco	Truck	2	13,000	13,000/2½" 7,000/3"	Yes
	5	Ideco	Truck	2	10,000	7,000/2½" 6,500/3"	Yes
	6	Crdwll	Truck	2	10,000	7,000/2½" 6,000/3"	—
	7	Ideco 30	Trailer	2	13,000	13,000/2½" 7,000/3"	Yes
	8	Ideco H-25 AD	Truck	2	11,500	10,000	Yes
	9	Ideco 30	Trailer	2	13,000	13,000/2½" 7,000/3"	Yes
	10	Hydrair	Tractor	2	—	—	—
	14	Ideco 30	Trailer	2	13,000	13,000/2½" 7,000/3"	Yes
OHIO							
Portage County							
Glenn Gillespie & Sons Inc	8	Cooper Skytop	Self-prop	1	—	10,000	Yes
TEXAS							
Midland							
Kinsey & Ham Inc	2	Crdwll	Trailer	2	15,000	15,000/2" 9,000/5½"	Yes
	2	Crdwll	Trailer	2	13,500	13,500/2"	Yes

Canadian Well Servicing Rigs

Contractor's Name	Rig No.	Make & Model No. of Unit	How Unit is Transported	No. of Drums	Estimated Capacity Swabbing	Estimated Capacity Pulling	Can Unit Also Drill?
ALBERTA							
Leduc							
Gamache Well Serv Ltd	3	Frnks Rocket	Truck	2	6,500	8,000/2"	Yes
Camrose							
Gamache Well Serv Ltd	2	Frnks Rocket	Truck	2	5,000	4,500/2"	Yes
Breton							
Redwell Serv Co Ltd	1	Crdwll H	Truck	1	9,000	7,000/2" 5,000/2½" 3,500/8"	No
Brooks							
Redwell Serv Co Ltd	6	Crdwll AL	Truck	2	9,000	7,000/2" 5,000/2½" 3,500/3"	Yes
Blackfalds							
Redwell Serv Co Ltd	7	Frnks Rocket 44	Truck	2	9,000	9,500/2" 7,000/2½" 5,000/3"	Yes
Cynthia							
Redwell Serv Co Ltd	12	Frnks Rocket	Truck	2	7,000	9,000/2" 7,000/2½" 5,000/3"	Yes
Drayton Valley							
Redwell Serv Co Ltd	11	Frnks Rocket 44	Truck	2	9,000	9,500/2" 7,000/2½" 5,000/3"	Yes
	14	Crdwll AL	Truck	2	9,000	7,000/2" 5,000/2½" 3,500/3"	Yes
Edmonton							
Redwell Serv Co Ltd	15	Crdwll K-201	Truck	2	9,000	10,000/2" 7,500/2½"	Yes
Lodge Pole							
Redwell Serv Co Ltd	10	Frnks Rocket 44	Truck	2	9,000	9,500/2" 7,000/2½" 5,000/2"	Yes
Olds							
Redwell Serv Co Ltd	3	Crdwll H	Truck	2	9,000	7,000/2" 5,000/2½" 3,500/3"	Yes
	13	Crdwll AL	Truck	2	9,000	7,000/2" 5,000/2½" 3,500/3"	Yes
Stettler							
Redwell Serv Co Ltd	2	Crdwll H	Truck	1	9,000	7,000/2" 5,000/2½" 3,500/3"	No
	5	Crdwll AL	Truck	2	9,000	7,000/2" 5,000/2½" 3,500/3"	Yes
Sundre							
Redwell Serv Co Ltd	9	Frnks Clipper 65	Truck	2	9,000	13,000/2" 10,000/2½" 7,000/3"	Yes
Whitecourt							
Redwell Serv Co Ltd	8	Frnks Clipper 65	Truck	2	9,000	13,000/2" 10,000/2½" 7,000/3"	Yes

U. S. Cable Tool

Smith K Cable Tools 1801 Van Buren Great Bend Kans

Contractor's Name	Rig No.	Type Power	HP of Driving Engine	Rated Drlg. Depth-Ft.	Rig Make & Model
KANSAS					
Ellis					
K Smith Cable Tools	1	gas-prop	140	5000	Wlkr-Neer

RIG-UP FASTER.. MAKE HOLE SAFER

with CONTINENTAL-EMSCO B-SERIES PORTABLE MASTS

FASTER — Continental-Emsco's B-Series Masts shorten rig-up time to a minimum. Exclusive rear leg pivot permits time-saving low-level assembly . . even with high substructure no ramps are needed. Mast sections and crown assembly quickly go together with simple pin connections.

Mast raises smoothly, safely in one continuous operation. There's no need for snubbing lines, since B-Series masts never go over center . . raising lines remain in tension at all times during raising or lowering. Masts can be moved in one piece or knocked down into easily portable sections.

SAFER — All load bearing base connections are at floor level and can be readily seen by the driller. Leveling, to correct substructure settlement, is quick and easy. Driller has a clear view to top of mast, since interior and skew bracing is kept to a minimum. Continental-Emsco's mast design allows maximum block travel for faster, safer hoisting.

All masts meet API specifications for hook load and substructure capacity. Wind load capacity is 75 mph with full setback of pipe.

Contact your local Continental-Emsco representative for full details.
Continental-Emsco Masts are also available through leading supply stores.

Choose your next mast from one of these . .

B-127
Clear Height 127'.
Nom. Gross Capacity
416,000 lbs.

B-133
Clear Height 133'.
Nom. Gross Capacity
590,000 lbs.

B-134
Clear Height 134'.
Nom. Gross Capacity
830,000 lbs.

B-142
Clear Height 142'.
Nom. Gross Capacity
1,053,000 lbs.

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide

M902R

CONTINENTAL-EMSCO COMPANY, a Division of The Youngstown Sheet and Tube Company. General Offices: Dallas, Texas; Export Division: 30 Rockefeller Plaza, New York, N. Y. • Continental Emsco Company Limited, General Offices: Calgary, Alberta, Canada Continental-Emsco Company C. A., Caracas, Venezuela • Plants: Houston and Garland, Texas; St. Albans, Herts, England • *Representatives in All Principal Oil Fields of the World*

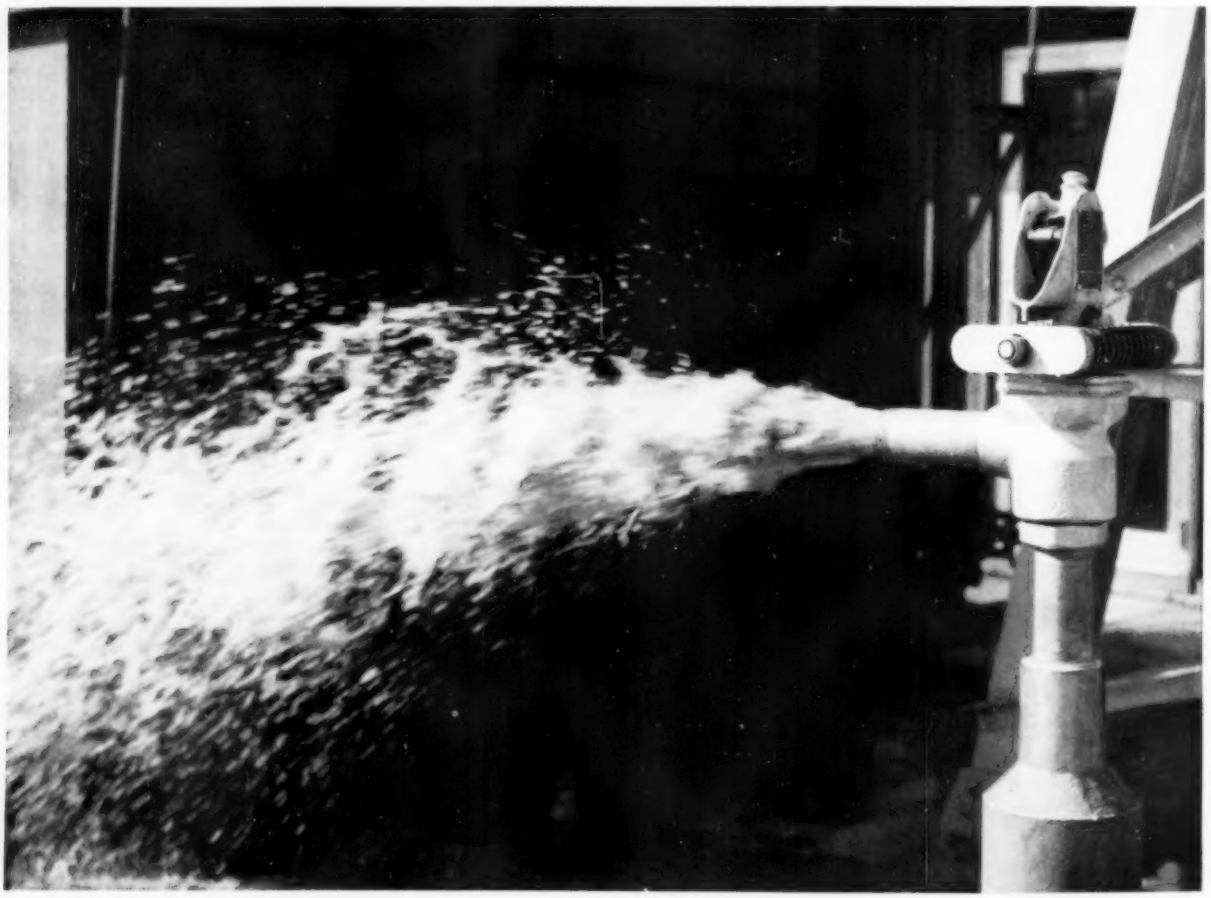
The Cameron Type "A" Reset Relief Valve is a brand new idea – an entirely new type of pressure relief valve. This valve, instantly adjustable in service to the desired relief pressure clearly shown on a calibrated scale, *opens fully* when the pressure exceeds that point and remains fully open until it is manually reset. Abrasive fluids and slurries are no problem because there is no throttling, no leakage, no wire drawing, no cutting – the valve is either fully closed or, instantly, fully open. No special tools and little effort is required for resetting. Operating of the reset lever merely returns the linkage to the set position and does not have to overcome compression of springs.

The Cameron Type "A" Reset Relief Valve assures unequaled safety, performance and economy through these advantages: 1. Continuously adjustable to relieve at any pressure within range – 1500 to 5000 psi or 750 to 2500 psi. 2. Opens full – no throttling effect or wire drawing. Piston moves clear and stays clear until valve is manually reset. 3. Single setting nut easily adjusts to exact relief point, clearly shown by a pointer and a calibrated scale – even with pressure in the valve. 4. Surging pressure, vibration or extended operation does not affect accuracy of setting. 5. Moving a single lever resets the valve, no shear pins or special tools are required. 6. Complete safety in operation – no unguarded moving parts – no flying pieces of shear pins. 7. A release button provides quick, easy discharge at any time, regardless of line pressure. A light tap with hammer will discharge it at maximum pressure.

Cameron

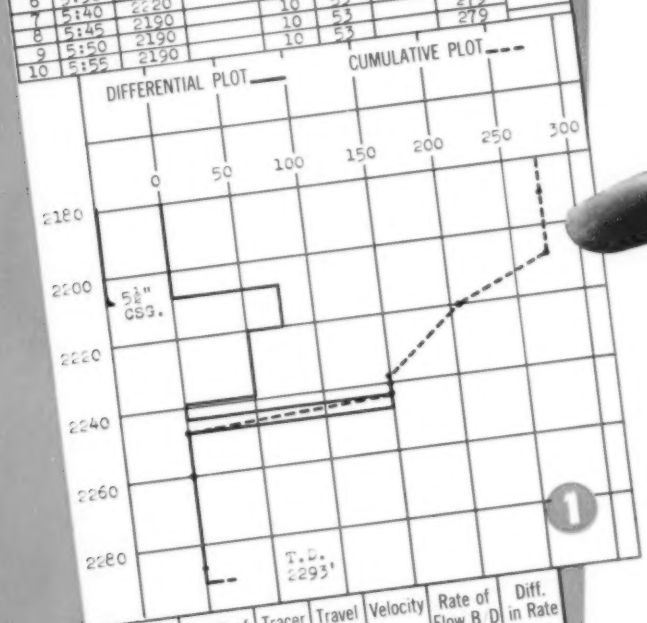
CAMERON IRON WORKS, INC.
P. O. BOX 1212 HOUSTON, TEXAS

POSITIVE PRESSURE PROTECTION

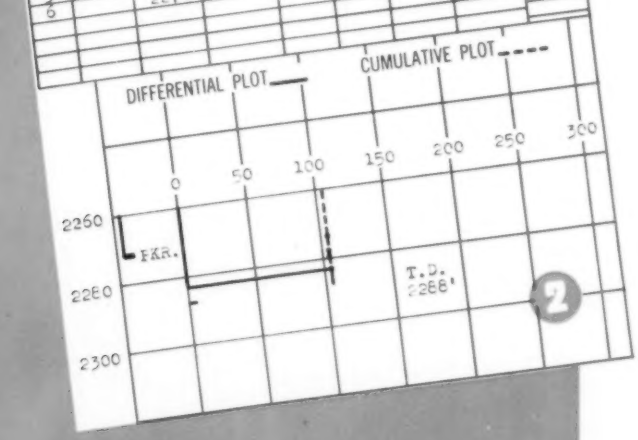


Another FIRST by LANE-WELLS

Shot No.	Time of Day	Depth of Detector	Depth of Mid Point	Tracer Travel Feet	Travel Time Sec's	Velocity Ft/Sec	Rate of Flow B/D Q K/t	Diff. in Rate
				10	334		0	
				10	325		0	
1	5:00	2287		10	300		0	152
2	5:07	2260		10	97		152	0
3	5:15	2248		10	97		152	0
4	5:20	2244		10	97		152	51
5	5:25	2240		10	73		203	76
6	5:30	2239		10	53		279	
7	5:40	2220		10	53		279	
8	5:45	2190		10	53		279	
9	5:50	2190						
10	5:55	2190						



Shot No.	Time of Day	Depth of Detector	Depth of Mid Point	Tracer Travel Feet	Travel Time Sec's	Velocity Ft/Sec	Rate of Flow B/D Q K/t	Diff. in Rate
				5	12		110	0
					12		110	0
1	11:30	2283			12		110	0
2		2279			12		110	0
3		2279			15		110	0
4		2276			15		110	
5		2274						
6		2274						



LANE-WELLS CO.
HOUSTON, TEXAS
LOGGING · PERFORATING · PACKERS · BRIDGING PLUGS

DRESSER INDUSTRIES, INC.
OIL · GAS · CHEMICAL · ELECTRONIC · INDUSTRIAL

How LANE-WELLS *NEW*

Nuclear Flolog

put the finger on costly water loss in this injection well

1. In this West Texas waterflood operation extensive injection had not resulted in desired production. A Lane-Wells Nuclear Flolog was run in this well, and showed all injection water entering upper section of the zone between casing shoe and 2248 feet. On the basis of this information, a packer was set at 2273 feet to direct fluid into zone below.
2. Subsequent Nuclear Flolog showed all water entering the desired area, the lower five feet of the zone.

What the Nuclear Flolog Does

The Nuclear Flolog is a unique type of nuclear tracer survey which provides a profile of points of entry into or out of the formation.

By injecting 2 cc. of tracer laden material at each of a number of points in the borehole and recording the time required for this material to reach the detector a log of flow rates in the zones of interest is plotted and translated into barrels per day. **As many as 100 stations may be recorded on one run in the hole.**

This information is a valuable aid in determining the receptivity of injection zones and the possible need for corrective measures.

In producing zones, the exact area of production is established. The need for, and precise point of, corrective treatment can be determined.

In any operation where a log of downhole fluid movement is of value, the Nuclear Flolog is the answer. Ask your Lane-Wells representative, or write P. O. Box 1407, Houston, Texas, for further information.

BREAKING THE BARRIERS OF INNER SPACE

Formation testing has long played an important role in profitable production of oil and gas. As the search for production has gone deeper and deeper in the inner space of the earth, Halliburton's skilled research and development teams have opened new avenues through improved formation testing methods to find this production.

In its ultra-modern Research and Development Center, Halliburton provides complete facilities — executive encouragement — and valuable incentive to the highly skilled scientists, engineers, and technicians who are dedicated to the constant improvement of testing tools and techniques.

As a result, whenever you call upon your Halliburton Tester, you can rely on him to deliver top testing performance — performance that comes only with this kind of team effort behind it.

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